DOCUMENT RESUME

ED 339 671 SO 021 795

AUTHOR	Cheek, Dennis W., Ed.
TITLE	Broadening Participation in Science, Technology and Medicine: Proceedings of the Annual Technological Literacy Conference (6th, Washington, D.C., February 1-3, 1991).
INSTITUTION	National Association for Science, Technology, and Society, University Park, PA.
SPONS AGENCY	Carnegie Corp. of New York, N.Y.; Epsilon Pi Tau, Inc., Bowling Green, OH.; Pharmaceutical Manufacturers Association, Washington, D.C.
PUB DATE	91
NOTE	453p.
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01/PC19 Plus Postage.
DESCRIPTORS	Adult Education; *College Science; *Educational Opportunities; Educational Technology; *Elementary School Science; Elementary Secondary Education; Environment; Equal Opportunities (Jobs); Ethics; Females; Health; Higher Education; International Education; Medicine; Minority Groups; Moral Values; *Science and Society; Science Curriculum; Science Education; Scientific Literacy; *Secondary School Science; Social Problems; Technological Literacy

ABSTRACT

This document contains the text of 50 papers presented at a national conference that focused on the relationships among science, technology, and society (STS). Most of the papers presented featured one of five major thematic areas around which the National Association for Science, Technology and Society is organized: education and information; environment; health and biomedicine; moral, ethical, and philosophical perspectives; and technology, industry, and work. Several papers focused on the special theme of the conference: "Broadening Participation in Science, Technology and Medicine" (the STS community needs to encourage further participation by and seek out perspectives on women, minorities, and the international community in STS studies). The papers are divided into three main sections: broadening participation, the nature of STS and STS interactions, and education from kindergarten through post-secondary and beyond. A complete conference program also is included. (DB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED339671

SO 021 795

Broadening Participation in Science, Technology and Medicine:

Proceedings of the Sixth Annual Technological Literacy Conference

Washington, D.C.

February 1-3, 1991

Edited by

Dennis W. Cheek

with a foreword by

Stephen H. Cutcliffe

Organized by

National Association for
Science, Technology and Society (NASTS)

Co-sponsored by

Accreditation Board for Engineering and Technology
American Association for the Advancement of Science
American Federation of Teachers
American Society for Engineering Education
Association for Women in Science
Epsilon Pi Tau
Federation of Materials Societies
International Technology Education Association
National Council for the Social Studies
National Council of Teachers of English
National Education Association
National Science Teachers Association
National Women's Studies Association
North American Association for Environmental Education
Student Pugwash USA
Teachers Clearinghouse for Science & Society Education
Technology Education Division, American Vocational Association
Triangle Coalition for Science and Technology Education

Supported by

The Carnegie Corporation
Epsilon Pi Tau
Pharmaceutical Manufacturers Association

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
DENNIS W. CHEEK
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

The Sixth Annual Technological Literacy Conference (TLC-6) was held February 1-3, 1991, for which these Proceedings serve as the official published record. As with all past Technological Literacy Conferences, we have submitted the proceedings to ERIC in an attempt to disseminate them more widely to those educators with an interest in the now two-decade old field of Science, Technology and Society (STS) Studies. All previous TLC Proceedings are within the ERIC system either as issues of the Bulletin of Science, Technology and Society or in the last two years as free standing publications [ED 315 326 (TLC-4) and ED 325 429 (TLC-5)]. They can all be accessed through the descriptor "STS education." I hope you will find this year's set of papers informative, stimulating, and thought provoking.

Each year the National Association for Science, Technology and Society (NASTS) hosts the annual TLC meeting providing an opportunity for the ever-widening community of STS scholars, educators, policy makers, public interest groups, and many other constituencies to come together to share ideas and materials. NASTS is organized into five major theme areas: Education and Information; Environment; Health and Biomedicine; Moral, Ethical and Philosophical Perspectives; and Technology, Industry and Work. Each of these theme areas is represented by the papers included in this year's proceedings.

In addition, this year's TLC-6 Organizing Committee chose as its special conference theme: "Broadening Participation in Science, Technology, and Medicine." Thus, also reflected in this compilation are papers focusing on the STS community's need and attempts to encourage further participation by and perspectives on women, minorities, and the international community in STS studies.

As has been the case with all past TLCs, this year's meeting was exciting and thought provoking, and I hope readers of these Proceedings who were not able to attend will be able to sense some of the enthusiasm of that meeting through the following papers. I am indebted to the TLC-6 Organizing Committee and Staff for their outstanding efforts on behalf of NASTS and its annual meeting; it was due to their efforts that the conference was such a success. I am also grateful to Dennis Cheek, who has once again served the organization faithfully and tirelessly, for his efforts in editing these Proceedings. In addition, we both appreciate the efforts of Lesa Clark of the New York Science, Technology and Society Education Project (NYSTEP) for her help in the layout and production of these Proceedings.

I hope you will find these papers stimulating more extensive involvement in STS education, perhaps by joining NASTS and participating in future TLCs. To that end, a NASTS membership form follows. I hope you will join me and other members of the STS community in furthering our understanding of the complex relationships among science, technology and society.

Stephen H. Cutcliffe
Program Chair, TLC-6
President of NASTS, 1991-92

NASTS MEMBERSHIP FORM

Membership in NASTS includes the *NASTS Newsletter*

Name____
Title or Position__________________________________
Name of Organization______________________________
Address____
City/State/Zip___________________________________
Phone____________________
Fax____________________
BITNET/other computer network number____________________

☐ Please send information on the next Technological Literacy Conference

Indicate the one sector which best matches your area of interest:

____ Science and Engineering
____ Print and Broadcast
____ Public Interest Sector
____ K-12 Education
____ Post Secondary Education
____ Informal Education
____ Values, Ethics, Religion
____ S/T Policy
____ International STS

Indicate your major theme of interest:

____ Education and Information
____ Technology, Industry and Work
____ The Environment
____ Health and Bio-medicine
____ Moral, Ethical, Philosophical Perspectives

For Membership: Send check for $40 payable to "NASTS," 133 Willard Building, University Park, PA, 16802

Table of Contents

Foreword by Stephen H. Cutcliffe, President of NASTS

Broadening Participation

Women in science: Demanding a bigger piece of the pie or a new recipe?, *Zuleyma Tang Halpin* . . . . 1 - 3

Does Congress encourage women in science and mathematics?, *Rhea Jezer* . . . . 4 - 11

Education, technology and educational technology: A gender perspective, *Suzanne K. Damarin* . . . . 12 - 20

Technological progress: How outsiders see it, *Doris Z. Fleischer, Lisa Novemsky, Phyllis Young Langford, Frieda Zames, Ronald Gautreau* . . . . 21 - 26

Sequencing the human genome: A feminist assessment, *Helen Bequaert Holmes* . . . . 27 - 34

Values in ecofeminism and creation-centered spirituality: The difference they make in policy making, *Barbara Anne Radtke* . 35 - 42

Girl's play, woman's work, *Sandra A. Brick, Fred M. Amram, Mary Ellen Gee* . . . . 43 - 50

From ironing to transplants: Woman as inventor, *Fred M. Amram* . 51 - 58

The Nature of STS and STS Interactions

Defining STS: Can we reach consensus?, *Paul T. Durbin* . . . . 60 - 66

The social structure of nature, *John Bryne, Steven M. Hoffman, Cecilia R. Martinez* . . . . 67 - 76

From fusion frenzy to fraud: Reflections on science and its cultural norms, *R. Eugene Mellican* . . . . 77 - 96

Green economics and the developing world: Institutional strategies for sustainable development, *John Byrne, Insook Han, Jong-dall Kim, Young-Doo Wang, Rebecca J. Wykoff* . . . . 97 - 109

Energy and planning: Certainties in an uncertain world, *John Byrne, Constantine Hadjilambrinos* . . . . 110 - 118

Electronic inequality, *Thomas W. Simon* . . . . 119 - 125

Environmental/scientific knowledge and locus of control, *James P. Hamilton* . . . . .126 - 133

Language as fulcrum in science and humanities, *Stephen Tchudi* . 134 - 149

Broadening the scope of engineering ethics: From micro-ethics to macro-ethics, *Robert Hudspith* . . . . 150 - 155

Education from Kindergarten through Post-Secondary and Beyond

General Issues

Changing the focus: Fostering the development of science, technology and society programs in schools, *William F. McComas, Susan M. Blunck, Julia M. McArthur, Mark A. Brockmeyer* . . . . 157 - 169

Personalization: The missing element in STS education, *Paul C. Jablon* . . . . 170 - 171

A critical perspective on STS: STS, school reform, and corporate conceptions of education for work, *Raymond R. Grosshans* . . . . . 172 - 185

Everyday ethics in undergraduate laboratories, *Linda M. Sweeting* 186 - 190

Communicating environmental risk at the high school/college level: An S.T.S. simulation approach, *James P. Hamilton* . . . . 191 - 203

Elementary Education

Restructuring elementary school science in-service education for improved teaching and learning, *Jack Rhoton* . . . . 204 - 213

L.A.S.E.R.S and language arts: Natural links, *Aline M. Stomfay-Stitz* 214 - 224

Secondary Education

The Health Academy: A model project encouraging minority students to enter health careers, *Natalie Hannon, Ronald Paul, Lisa Brandon-Rodriguez* . . . . 225 - 227

Toward the twenty-first century: Problem solving through science, technology and society for a middle-level science curriculum, *William T. Peruzzi* . . . . 228 - 233

Research internships: An ideal tool to attract youngsters to choose careers in science and technology, *Dana Levine, Susan Fahrenholtz, Beatrice A. Klier, Victoria Leyton* . . . . 234 - 241

STS: Central to the Iowa scope, sequence, and coordination centers, *Robert E. Yager* . . . . 242 - 251

A true interdisciplinary approach to STS, *Steven Fleury, Roger Hinrichs, Carlton Salvagin* . . . . 252 - 255

Introducing engineering and technical subjects across the disciplines at the high school and middle school levels: NSF sponsored interdisciplinary summer institutes, *Edward Jay Pershey* . . . . 256 - 260

The Illinois Rivers Project, *Robert A. Williams, Marylin Lisowski, Kim Niemietz* . . . . 261 - 274

Fire: From Prometheus to thermodynamics, *Louis B. Rosenblatt* . 275 - 280

"Too much garbage!" : The problems of landfills, groundwater contamination, and recycling, *Mark A. Brockmeyer* . . . . 281 - 288

An innovative CAD program, *Joseph E. Ryan* . . . . 289 - 290

Math education today - - Bear or bull market?, *Russell E. David* . 291 - 293

Issues in nuclear energy: An STS unit for high school chemistry, *Kevin Koepnick* . . . . 294 - 303

Lawn clippings: A STS issue, *Lloyd H. Barrow* . . . . 304 - 306

Electronic principles and applications: Using a hands-on, S-T-S, concept-based curriculum design, *Michael Jaeger* . . . . 307 - 315

Post-secondary and Beyond

STS, women's studies, and the transformation of the undergraduate curriculum, *Barbara Beigun Kaplan* . . . . 316 - 329

Technological literacy at the community college level: Pedagogical methods, *Louis Rodriquez* . . . . 330 - 335

Mutually assured instruction: Team-teaching an interdisciplinary course entitled "Science and human values", *Richard S. Demaree, Jr., Ron Hirschbein* . . . . 336 - 340

Design and implementation of an "STS" core curriculum in the health professions, *Robin A. Harvan* . . . . 341 - 348

Ethics in the teaching profession, *Newton D. Gregg* . . . . 349 - 351

Issues-directed science education - Theory and applications in biology and chemistry, *David L. Adams, James R. Philips* . . . . 352 - 359

International Perspectives

A course in science, technology, and society, *Eknath V. Marathe* . 360 - 367

Why does Japan need STS? A comparative study of secondary science education between Japan and the U.S. focussing on an STS approach, *Yoshisuke Kumano* . . . . 368 - 390

Socio-political dimensions in civil engineering education at the University of the Witwatersrand, *R. T. McCutcheon* . . . . 391 - 398

The influence of society's values on the mathematics curriculum in the U.S. and France, *Marguerite Gravez* . . . . 399 - 403

International representation in science, technology and medicine, *David K. Addae, David L. Lickteig* . . . . 404 - 410

Research, innovation and project work in secondary schools - Effective STS education, *Sreco Zakrajsek* . . . . 411 - 413

Complete Conference Program

Broadening Participation

WOMEN IN SCIENCE: DEMANDING A BIGGER PIECE OF THE PIE OR A NEW RECIPE?

Zuleyma Tang Halpin
Department of Biology and Women's Studies Program
University of Missouri - St. Louis
8001 Natural Bridge Road
St. Louis, Missouri 63121
(314) 553-6498

Much of the attention and debate on women and science has focused on recruiting and retaining women who go into science, that is, on working to get women a bigger piece of the pie. Typically, this approach has not questioned the very definition and structure of science as it is taught and practiced in the western world today. This paper analyzes the structure of western science and argues that this very structure is one of the most important factors responsible for the dearth of women in science.

Both science and womanhood, as gender, have been socially constructed. Since historically, the vast majority of scientists have been white men, it is not surprising that white men have been the ones who have defined and constructed our current understanding of science--and this male construction is one that emphasizes separateness and separation.

In the case of science, separateness and separation have been codified in the concept of scientific objectivity. Scientific objectivity, which is considered the cornerstone of science, has been defined to include two fundamentally dualistic formulations:

1) the separation of the intellect from the emotions
2) the separation of the "self" (scientist) from the "other" (object of study).

This formulation of scientific objectivity, which is taught from very earliest stages of science education, conveys the message that the essence of science is intellect and absolute rationality and that emotions and feelings of connectedness to the object of study are antithetical to the practice of science. Thus, aspiring young scientists are socialized to believe that emotions and feelings must never be allowed to enter any part of the process of science. This socialization attempts to ensure that only those individuals who are able to accomplish this separation of intellect from emotions and self from other go on to become scientists--those who cannot or will not drop out early in the game.

While many of us recognize that this formulation is a myth with regards to how science is actually practiced, the ideology is, nevertheless, seen as the ideal for which all scientists must strive. The results of this dualistic formulation of science are diverse. One consequence is that it promotes among scientists the belief that their work is purely intellectual and neutral and that, therefore, the scientist need not consider the human and social consequences of his/her science.

Robert Jay Lifton (1990) has referred to this as the "passion for problem solving" and argues that it is precisely this attitude that led to what he calls "the genocidal mentality" as exemplified both by Nazi science and by the development of weapons of mass destruction. This attitude has been apparent in recent weeks in the jargon, analogies, and euphemisms that are used as part of the Gulf War. Not only is there an euphoria about the success of weapons technology, but a war in which innocent people (and I include U.S. troops among the innocent) are dying on both sides is compared to a football game. We hear about "smart" bombs and missiles and this prevents us from thinking about the misery, death and destruction that these bombs carry with them. And we no longer talk about civilian deaths because dead human bodies have become "collateral damage."

Thus, the emphasis has been on our great scientific and technological achievements and not on the human suffering caused by war. It is indicative of how deeply this dualism has entered the psyche of our nation that we accept this as normal. Thus it could be argued that the dualistic formulations of scientific objectivity have spawned an ideology of domination, destruction, and inhumanity.

Michael Kunze (1987), the German historian, has perhaps expressed it best when he writes:

> "It was the emancipation of the intellect from the emotions that allowed human beings to practice inhumanity with an easy conscience."

Yet this is precisely the ideology that we are currently asking women, and men of color, to embrace if they want to be scientists -- an ideology that has contributed to their own oppression.

In some of my previous work (Halpin 1989) I have tried to make the connection between the dualistic formulations of scientific objectivity and scientific oppression of women and minorities. But today I want to consider another consequence of these dualisms that affects both men and women scientists -- human alienation. I would argue that a definition of science that demands that scientists separate their intellect from their emotions and deny their connectedness to the rest of nature is dehumanizing because it requires a fragmentation of the self as a human being. The scientist becomes a dual being--a divided self--allowed to feel emotions in some contexts but never in others. Thus, a science based on dualities refuses to recognize the scientist as a full human being and denies that the practice of science is a human endeavor (in the full sense of the word human). Being a scientist, therefore, becomes incompatible with being fully human.

It is ironic and paradoxical that by denying the very basic, integrated humanity of the scientist, the dualistic formulation, which so extols rationality, is exposed as a fundamentally irrational paradigm. Women scientists suffer an even more severe form of alienation because, given the demands of science and the social construction of womanhood in our society, being a scientist and being a woman can be perceived as mutually exclusive.

While women's socialization stresses connectedness, compassion, caring, and concern for the welfare of others, the dualistic formulations of scientific objectivity tell us that these characteristics are incompatible with being a good scientist. Women scientists are therefore more likely to perceive science as a hostile environment--essentially a male environment--and to see themselves as "strangers in a strange land."

The fact that science is an inhospitable environment for women, and that as Cole (1981) has so aptly put it, the women who have stayed in science are at best only "survivors", is not lost on aspiring young women scientists. The young woman in science class is told she must not feel, yet society tells her that feeling and compassion are part of what defines her as a woman. If she expresses concern about the treatment of animals in research, she will most likely be informed that if she cannot overcome her emotions she does not have what it takes to be a scientist. Lastly, as a young scientist, she will be expected to embrace a paradigm that rejects the fullness of human experience and which devalues precisely those characteristics that she has been taught to value.

Given our current definition of science and the socialization of women I do not find it surprising that relatively few women are attracted to science. My point is that while it is certainly laudable to try to recruit more women into science, we cannot afford to ignore the dehumanizing and anti-women perspectives that are inherent in science as it is taught and practiced today.

Recruiting more women to science and increasing the numbers of women in science is not enough. We must question the socially constructed definitions of both womanhood and science, and work to create new, non-dualistic definitions of science that safeguard true scientific objectivity, which includes a recognition of the fact that as human beings we can never totally separate our feelings from our intellect, or ourselves from nature, and that recognizes that science, as a human endeavor, can never be completely neutral or value free.

By doing so, we are more likely to give rise to a new science that is more humane, and that recognizes the perspectives of women and people of color as valuable. Such a transforming reconstruction of science will do more to increase the numbers of women and people of color in science, than remedies that seek only to increase the numbers of these constituencies in a field that remains profoundly alien and alienating to women and persons of color.

References

Cole, J. R. (1981). Women in science. *American Scientist 69*:385-391.

Halpin, Z. T. (1989). Scientific objectivity and the concept of "the other." Women's *Studies International Forum, 12*(3), 285-294.

Kunze, M. (1987). *Highroad to the State: A Tale of Witchcraft.* Chicago: University of Chicago Press.

Lifton, R. J. (1990). *The Genocidal Mentality: The Nazi Holocaust and Nuclear Threat.* New York: Basic Books.

DOES CONGRESS ENCOURAGE WOMEN IN SCIENCE AND MATHEMATICS

Rhea Jezer
4 Standish Terrace
Syracuse, New York 13224
(315)446-7060

The United States is suffering from a severe and worsening shortage of scientists, one that threatens the nation's ability to compete internationally. If present patterns continue, the United States will experience a net shortfall of approximately 750,000 scientists and engineers by the year 2000. The situation is so obviously dangerous from a political and economic point of view that it deserves the serious concern of policymakers and academicians, as well as the military and business community. (FCCSET)

America is facing a significant challenge in education. Particularly in science and mathematics, student performance is extremely weak compared to international peers. Our teachers are often inadequately prepared in math and science, and insufficient numbers of students are pursuing education and training to fill critical scientific and technical jobs. Further, the scientific literacy among the American public in general is extremely low. (FCCSET)

One major problem is that there is a severe underrepresentation of women in science courses and careers. Although women constitute approximately 50% of the total professional workforce, they represent under 13% of our scientists and engineers. (National Science Board) Women make-up a vast and important untapped resource.

In 1983, Sixteen years after the nation's first assessments of science proficiency among 9, 13 and 17 year olds, our children performed below the 1970 levels in every age group, and well below the levels of children in other nations. What is so appalling is that the performance gap between 13 year old boys and 13 year old girls has more than doubled and the gap even at age 9 has increased. (Mullis & Jenkins) By age 17, an immense disparity exists between performance by men and women in the field of science and math. (Vetter)

Differential treatment as well as differences in opportunities for women in science and math instruction have been documented. (Keynes) While girls do score, on the average, 45 points lower than boys on the math portion of the SAT exams, this has been attributed more to enrollment in and exposure to math courses and mathematical principles in high school than to ability. (Shakashiri) Boys usually take, on the average, one more math class than girls do. Most often this course is calculus, which tends to correlate with high scoring in SAT-Math. (Pelavin) Teachers and textbooks, as well as parents and socialization patterns, also contribute to the lower performance by women. (Cole & Griffin) Girls who are talented in those fields are less likely than similarly talented boys to be selected by their teachers for special programs, to be recognized by their families as exceptional and are often not provided with a supportive home environment.

Studies indicate that there are no innate differences in abilities by gender or race in science and mathematics. The problem is clear: there is differential treatment as well as differences in opportunities for boys and girls in science and mathematics.

(Shakhashiri) The entire pipeline has flaws. In elementary school girls are not encouraged by teachers to enter special programs and they are discouraged as well from taking advanced courses in high school and college.

Women are underrepresented in higher levels of the educational system and in the private sector, sending a clear message. A "cold climate" is often subtly suggested to women when they do fight up the career ladder in science, and the glass ceiling is evident. The women who make it up the ladder often suffer pay differentials and slower promotional rates. (Vetter) We must recruit and retain more women and minority faculty in the sciences.

There are ways to encourage women as well as underrepresented minorities to study science and math. (Reynolds, Clutter) These include the introduction of role models, the use of intervention programs, sensitizing and familiarizing teachers with the subtle ways by which they discriminate by gender and race, and encouragement of students by creating a classroom climate of high expectations and self-esteem.

However, in order for women to achieve in science and mathematics and choose those fields during college years, they must have the appropriate skills. Yet, high school guidance counselors tend not to encourage women to prepare in the sciences. There is conscious and unconscious bias by high school counselors and there is a need to expand their knowledge of career alternatives in the sciences for women.

In 1980, during the 96th Congress, committee hearings exposed the need for legislation to encourage women to enter the fields of science and math. The Reauthorization of the National Science Foundation for that year provided for a section on "Women In Science" (P.L. 96-516) However, eight years later, in 1988, it became apparent from those testifying at congressional hearings that because of lack of funding, little progress had been made in encouraging women and underrepresented minorities into the science pipeline and the problem still existed. (Malcom) That same problem exists today.

The need for scientists, however, still grows. The lack of technological skills in our society is preventing us from competing well against other industrial nations, and much of this is due to our deficiencies in the teaching and retention of students in the fields of science and mathematics. We must begin to take advantage of the educational potential waiting to be tapped. We must provide women as well as underrepresented minorities with the appropriate skills to achieve in these fields. It was reported recently that over 50% of the elementary school teachers in this country have never taken a science or mathematics course past high school. (FCCSET) These teachers, a vast majority of whom are women, are role models for girls. They are also one of the first influences on our future generation. If they are not trained in science and mathematics, neither will our next generation be prepared in these fields.

It is documented that women graduate students in the sciences are presently less likely than men to have either institutional or Federal support during their graduate studies. Teaching and research assistanships are not afforded equally to women as to men.

Women are more likely than men to be self-supporting or to have to borrow money to get through graduate programs in science. (Vetter) There is, consequently, a clear message being sent to those women who would like to choose science as a career.

During the last hours of the 101st Congress, an "Excellence in Education" Bill was passed. The provisions in this Law, relevant to women in science, include grants to institutions to recruit and retain women faculty, a Distinguished Visiting Professors grant, priority of awards to States or State agencies who emphasize women in math and science, provisions to encourage an increase in the number of fellowships going to women, and the recruitment and retention of women on faculties. (PL-101-589) Many of these are not new programs. It also remains to be seen if appropriations will fully fund these programs due to our present budgetary constraints.

The process to get a bill finally passed by both houses and into public law is painstaking and long. Often, several committees work on similar bills, each with their own particular emphasis. Committee hearings are intensive, long and varied, and the testimony exposing the problems with the bill is contained in many volumes. When and if the various bills survive to the point of final "mark-up", many provisions are bargained away for the sake of compromise. When the bill finally does become public law, the provisions then need to be funded, which is the next and sometimes insurmountable step.

This session of Congress, the Reauthorization of the Higher Education Act of 1965 will come before both houses. After a careful reading of the act, it became clear to me that nowhere in any of the several reauthorizations was language included to encourage women and minorities to enter the fields of science and mathematics. I therefore proceeded on a project to draft a bill that would include provisions throughout this very far reaching act, for women and minorities in science education. One of the fruits of this labor is HR 2142, which will be introduced by Rep. Nita Lowey on May 1, 1991.

Called "The Women and Minorities in Science and Education Act", HR 2142 is an attempt to alleviate the problem of inequity in the education of women and minorities in the fields of science and mathematics. The bill amends the Higher Education Act to encourage women and minorities underrepresented in the fields of science and mathematics to enter these fields. The bill provides for training of faculty and staff to develop educational programs specific to the encouragment of women and underrepresented minorities in the fields of science and mathematics, and to enhance relevant their pedagogical skills. It also provides for teacher recruitment and retention of women and underrepresented minorities in the fields of science and mathematics through scholarship assistance and midcareer teacher training.

Special funds are earmarked to support models for training for women and minorities who seek work in the fields of science and mathematics, and program authority for a talent search to encourage women and underrepresented minorities to enter these fields. The bill provides for high school counseling for girls and minorities to encourage them to take courses to prepare them for entrance into the fields of science and technology as well as grants to school, college and university partnerships designed to encourage women and minorities in these fields. The bill authorizes resource centers designed to encourage model and cooperative education in the fields of science and mathematics for women and underrepresented minorities, and grants to institutions for graduate programs designed to encourage a larger number of women and underrepresented minorities to enter the fields of science and mathematics.

Another bill I drafted amends the provisions for the Christa McAuliffe Fellowship which is part of Title V of the Higher Education Act. The wording reinterprets the program as a fellowship specifically for a woman teacher, for the specific purpose of the integration of the science and social studies curriculum. This language memorializes the work done by Christa McAuliffe.

A third bill, will establish a position at the National Science Foundation to be known as the Directorate of Women in Science. The Director will be responsible for oversight and assessment of programs that encourage women to enter and remain in the fields of science and mathematics.

There is definitely interest by members of Congress and by the Executive to encourage science education in general. The interest in including special provisions for the encouragement of women in science and mathematics is more problematic. It is up to those who realize the vast human potential available as well as those concerned with equity issues for women, to lobby for the specific inclusion of the encouragement of women to enter the scientific fields. Supporting bills specific to this inclusion is of utmost importance.

REFERENCES

Babco, Eleanor, (1990) **Salaries of Scientists, Engineers and Technicians,** Fourteenth Edition. Washington DC: Commission on Professionals in Science and Technology.

Clutter, Mary E., (1989) **Achieving Full Participation of Women In Science And Engineering: A Report of the National Science Foundation's Task Force On Women in Science and Engineering** Wash.DC:National Science Foundation.

Cole, Michael and Peg Griffin, (1987) **Contextual Factors in Minorities and Women** (Ed), Wisconsin Center for Education Research, University of Wisconsin-Madison (Ed.), Madison Wisconsin.

FCCSET COMMITTEE, (1991) **By The Year 2000: First In The World,** Report of the FCCSET Committee on Education and Human Resources, Wash:DC: Office of Science and Technology Project.

Keynes, Harvey B. (1989) *"University of Minnesota Talented Youth Mathematics Project (UMTYMP)"* MANPOWER COMMENTS, v.26, no. 9, November.

Malcom, Shirley M. (1989) Prepared Statement before Senate Committee on Labor and Human Resources, Examining The Status of American Math, Science and Engineering, November 14, 1989

Mullis, Ina V.S. and Lynn B. Jenkins, (1988) **The Science Report Card: Trends and Achievement Based on the 1986 National Assessment,** Princeton, N.J.:Educational Testing Service.

National Science Board, (1989) Science and Engineering Indicators - 1989. Washington DC: U.S. Government Printing Office.

National Science Foundation, (1990) **Women & Minorities in Science and Engineering** Pub.90-301 Wash. DC:National Science Foundation.

Pelavin & Associates, (1990) **Changing the Odds: Factors Increasing Access to College.** Publication #003969. New York: The College Board.

Quality Education For Minorities Project, Education That Works:An Action Plan For The Education Of Minorities (1990) Cambridge, Mass:Massachusetts Institute of Technology.

Reynolds, W. Ann & Jaime Oaxaca Changing America: The New Face of Science and Engineering: The Task Force on Women, Minorities, and the Handicapped in Science and Technology, Interim Report (1988) September Wash.DC.

Shakhashiri, Bassam *"U.S. Science Education"* in Human Resources in Science and Technology: Improving U.S. Competiveness. Proceedings of a Policy Symposium for Government, Academia and Industry. (1990) Washington DC: Commission on Professionals in Science and Technology.

Vetter, Betty M. Women in Science and Engineering: An Illustrated Progress Report (1990) Washington DC: Commission on Professionals in Science and Technology.

EDUCATION, TECHNOLOGY, AND EDUCATIONAL TECHNOLOGY: A GENDER PERSPECTIVE

Suzanne K. Damarin
The Ohio State University
29 W. Woodruff Ave.
Columbus, OH 43210
(614) 292-4872

"Broadening Participation in Science, Technology, and Medicine," the theme of this conference, is also the theme of many current efforts of the organizations of science, engineering, mathematics, business, government, and education. The theme appeals to virtually all who know of it in one or more of its various expressions: **recruit** more women and minorities to the study of science, **provide opportunities** for more women and minorities to study science and/or to pursue scientific careers; **increase the representation** of women and minorities in scientific fields; allow women and minorities **a greater role in and influence on** the development of science and technology; **improve the scientific education** of school students, especially minority students who form an increasing percentage of the school population. Under the "umbrella concept" of increased participation, these efforts toward recruitment, increased representation, expanded roles, and improved education become indistinguishable and unarguable; the idea of "increased participation in science, technology, and medicine" is reified as a societal goal, although it means different things to different people. For example, while I might support the teaching of "radical math" to increase the participation of working class adults in the analysis of (and resistance to) the effects of technology on their lives (Frankenstein, 1987), or the participation by increasing numbers of well-informed women in the debates concerning reproductive technologies and the effects of these technologies on their lives (e.g., Corea, et al., 1986), I don't expect that my concerns are exactly what researchers at DuPont and IBM, the stockholders of Gentech, or my local politicians have in mind, even as we all share in the support of "broader participation."

To observe the obvious, when scientists, who are already participants, call for broader participation in science, they mean to effect the participation of persons other than themselves. What is not so obvious, is that ***almost all*** who speak of the need for more people to engage in the study and activity of science and technology are calling for the participation of someone else, not themselves. Entrepreneurs, personnel managers, politicians, and guidance counsellors have all elected to engage their lives in activities outside the domains of science and technology, yet call upon others to make commitments to these fields. The general public appears to support the importance of science and technology as societal efforts; we note, however, that the numbers of American born students who are entering many fields of science and technology are decreasing, and that the National Assessment of Educational Progress indicates not only a low level of scientific knowledge, but also attitudinal enigmas. In the most recent mathematics assessment, for example, the overwhelming majority of eighth graders interviewed felt that mathematics was important in general, ***but not for them***. (Lindquist, 1991). Already, they felt that ***someone else*** should do it!

This data is reminiscent of data collected by Betty Collis (1985) concerning the attitudes of male and female students toward computer technology. Both boys and girls in Collis' sample felt that males and females were competent in the use of computers, and that it was equally appropriate for males and females to use computers. However, ***for themselves*** young women frequently felt that the computer provided an inappropriate environment, in part because as individuals they thought themselves to be relatively incompetent. In short, for many students, and, in particular, for many young women, the study or use of computer technology was seen as appropriate only for "the other."

The "othering" of the scientist is not an activity limited to the domains in which people contemplate or pursue their own activities or careers. As Doriothy Nelkin points out

> Just as science is described as divorced from normal human activity, so the scientist, at least the male scientist, is portrayed in popular newspapers and magazines as socially removed, apart from, and above most normal human preoccupations (Nelkin, 1987, p.17).
>
> That a prestigious scientist can behave like ordinary mortals is noted with an air of surprise (p.18). If male scientists are portrayed as other to the rest of us, then female scientists are other to their male counterparts. Again from Dorothy Nelkin:

The overwhelming message in these popular press accounts, is that the successful woman scientist must have the ability to do everything --- to be feminine, motherly, and to achieve as well. Far from being insulated and apart from ordinary mortals, women scientists are admired for fitting in and for balancing domestic and professional activities (p.20).

And, if the public press portrays the scientist as other to the majority of its readers, the writings of scientists and technologists who address the public often construct and stereotype those outside their fields as "other." John Allen Paulos' introduction to his book ***Innumeracy***, for example, details the personal shortcomings which "plague" the mathematically illiterate (Paulos, 1988, pp. 3-5). Using terms such as weakness, perverse pride, failings which are hidden, various inadequacies, strong tendency to personalize, to be misled, and so on, Paulos characterizes the innumerate as other to the mathematically literate.

As we look at the issue of broadening participation in science and technology, what we appear to be dealing with is not C. P. Snow's ***Two Cultures*** (1963), but a complex web of relations of otherness. The issue is not one of communicating across a single cultural divide; in fact, the fascination of writers and literary critics with developments in science and technology (e.g., Hayles, 1990) may be bridging this divide. Nor is it a simple matter of recruiting novices to the camp of science. Rather, it appears to be an issue of disentangling the dense web of otherness and decreasing the social distance that othering entails. To look at the meaning of "othering" more closely, we borrow from feminist theory.

Theorizing Othering and the Other

The concepts of "the other" and of "othering" are important to feminist theory because, by many accounts, beginning with Simone de Beauvoir's (1953) ground-breaking book ***The Second Sex***, the social construction of the female is as other to the male. Eve is created as other to Adam; in psychoanalysis the female is theorized as other to (and envious of) the male. In his treatise on education, Rousseau describes at length the ideal education of Emile and then briefly, almost as an afterthought, turns to the education of Sophie, the "other" to whom the first four books of the treatise do not apply. Other examples abound. Similarly, African American feminists (e.g., bell hooks, 1990) examine the construction of blacks as other to whites, and Gayatri Spivak (1990) discusses the complex of otherings which affect her life as a woman of color, a distinguished academic, an Indian citizen living in the U.S. and a worldwide traveller. Examining some of the feminist writings around the concept of the other, we can hope to shed some light onto the othering of scientists by non-scientists and conversely.

The first observation is that the relation "other to" is not symmetric in the usual sense. To say that "A is other to B" is not equivalent to saying "B is other to A." Instead, the relation of "other to" is a power relation. The second term in the relation is the seat of power, and the first term is outside that power: female is (defined as) other to male, black is (defined as) other to white, eastern culture is other to western culture, foreigner is other to citizen, and so on. The power in this relation of otherness lies in the definition of the "other" **by the powerful, in relation to the powerful**. To define or describe an "other" is thus to claim power.

With respect to the web of otherings which inscribe science, we see by analogy that the common assignment of science and scientists to the category of other can be viewed as a power move, an effort to claim superiority over science by assigning it (using Nelkin's words) to the "socially removed" who do not engage in "normal human activity." In this context pride in failing mathematics and resistance to technology can be seen as components of the power claim of the general populace over science. At the same time, of course, science and scientists, technology and technologists claim power over the non-scientist by the othering which is implicit in the very word "non-scientist." To be "not a scientist" is to be defined by science in relation to science, and thus to be declared as lacking in some dimension of that which scientists assert as essential: for example, rationality, objectivity, systematicity, or specific knowledge. "Othering" is also common within science and technology, as subgroups, discoveries, or artifacts claim titles ranging from "leading edge technology" to "socially responsible science." In each of these moves, those who claim the title simultaneously "other" those who are then described as "not leading edge" or "not socially responsible."

This brings us to a second key concern, essentialism. In feminist debate, the essentialist position asserts that (beyond the obvious and biological) there are certain samenesses among women which can be considered to be the "essence" of the feminine. The anti-essentialist position holds that othering entails the attribution to the other (that is, the woman) of characteristics which legitimate her oppression; these "samenesses" are not "real" or essential characteristics; rather, their imposition is intended to deny women their difference. individuality, and social mobility (Schor, 1989). The essentialist position has a certain appeal to some because it allows for "eternal verities;" however, it also lends itself not only to vicious stereotyping but also to claims for uniquely feminine virtue and even to claims of female superiority over males. In my view, the anti-essentialist position is more "correct," in part because it is useful in liberatory projects; it broadens rather than limits the domains and activities for female participation.

Borrowing the concept of essentialism/anti-essentialism and applying it to the othering both of science/technology by the public and to the othering of the general public by spokespersons for science/technology, it seems clear that the essentialist position is implicit in the othering discourses. Nelkin reports and Paulos belies, a clear and pernicious stereotyping of their respective others. In these opposing stereotypes each "other" might find claims for superiority and "eternal verities" which continue the separation of these "others" and preclude the broadening of the participation of the populace in science and technology. A commitment to not essentializing, and even to anti-essentializing of both scientist and non-scientist seems critical to the process of broadening participation.

What Does this Mean for Education?

If broadened participation of the general populace (including women, ethnic minorities, people of all ages, the differently abled, and so on) is truly a goal, education in one form or another must play a substantial role in achieving that goal. Current forms of science and technology education will need to be examined and overhauled. Following the analysis above, examination and revision of education will need to be responsive to (at least) the following issues:

1. Attention must be paid to the meaning of "broadened participation." If participation is to mean the development of expertise among a somewhat wider (but restricted) group of individuals the nature of the reforms needed will be different from those required if participation is interpreted to entail enlightened critique by non-experts.

2. The phenomenon of "othering" must be further examined and educational methods which replicate and reproduce othering

should be eliminated. Ways of countering the popular construction of science as other must be uncovered. The use of role models, women or minorities from the scientific professions, as classroom visitors is one step in this direction, but it is only a first step and others must be identified.

3. The essentializing of science and scientists and technology and technologists, as well as those persons and endeavors outside these fields must be eliminated Among other implications of this demand is the requirement that barriers to the study of science by those "outside the pipeline" and the study of other fields by those "in the pipeline" toward scientific careers must be removed (Damarin, 1988).

It is important to recognize, both in the literature on science and mathematics education and in instructional practice, the confounding of the concept of equity with the process of recruitment. There are two distinct global questions which relate women and minorities, science and mathematics, and access. First, do women and minorities have access to the power of mathematics and science as a means of understanding and constructing (or criticizing and deconstructing) conceptions and conditions of "reality"? The second, and different, question asks: do science and technology-intensive institutions (business, government, military, science) have access to women and minorities as workers who understand and perform mathematics? The confounding of these questions of access **by** and access **to** women and minorities is a political move which conflates arguments for empowerment and equity with efforts toward recruitment to the routine mathematical, scientific, and technical work of already powerful institutions. This conflation limits the meaning of participation and perpetuates othering both of and within science (see Harding, 1986). It essentializes participatory science and technology as a form of work in contrast to a form of understanding or knowing.

A Note on Educational Technology

Contemporary consideration of educational reform inevitably involves the consideration of educational technology; this is especially true of education related to mathematics, science, and technology, all areas in which numerous computer-based tools are available and are, in fact, used within the work-world of practitioners. As corollaries to the principles laid out above, several guidelines for the instructional use of technology emerge.

If the broadest construction of "participant in science, technology, and medicine" is intended, the Inverse Tool Principle (Belland, 1985) provides good advice: this principle states that the less skill a tool-user has, the more powerful the tool that is needed. Thus, powerful (computer-based) tools should be provided, especially for those participants who are not skilled in science and technology, but desirous of learning more about them. However, the application of this principle must be tempered by caution against technocentrism (Papert, 1987) in the selection of tools. Generally speaking, applications of computer technology to the teaching of mathematics and science has involved the use of tools which will perform tedious operations and/or allow the exploration of mathematical and scientific phenomena. For the practitioner in training, powerful tools which handle complex cases rapidly and repeatedly are desired; symbol manipulators, advanced graphing calculators, 3-d graphics packages and CAD/CAM software are useful for the performance of tasks. For the non-practitioner, however, the issue of importance may not be the power, efficient use, flexibility, and compatibility of a software package, but rather a rudimentary understanding of what it is that the software is doing, what range of inputs are acceptable, and what range of outputs are reasonable. Thus, for some participants, the power of a tool must be weighed against its transparency. Unless transparent, technological tools can operate like disciplinary jargon, both easing the work of the "insider" and serving as a barrier to the uninitiated.

Secondly, expert systems and simulations can be useful in providing students of mathematics, science, and technology with access to large amounts of information concerning "real world" phenomena and their inter-relations. In choosing expert systems and simulations, the "epistemic fidelity" of the representation of the "real world phenomenon" is always an important issue (Wenger, 1987). Generally speaking, however, the fidelity of a (computer) representation to knowledge of the phenomenon is judged only from the perspective of the expert in the field. This judgement may suffice for instruction in situations where the goal is the development of expertise, and thus a failure to interpret a representation in the same way that an expert does is indicative of a learning deficit. However, if the goal is to encourage participation by non-experts, more general approaches to the issue of epistemic fidelity are required. For general use, a representation must be simple but not simplistic

In these and other uses of educational technology, the purposes and utility of an instructional tool must be assessed in the light of the purposes and inclinations of the student. Ambiguity of representations, unnecessarily complex procedures, and computer output which creates an information overload rather than a clear and explicit summary, can all serve to separate a would-be participant from knowledge of science, technology, and medicine.

Conclusion

In summary, education may help to broaden the participation of "just plain folks" in science, technology, and medicine. However, to do so, it must be attentive to the removal of barriers which currently separate them from these fields. Principal among the barriers is the power struggle in which the scientists and the folks find themselves. This struggle may have many roots, not all of them in education, educational materials, and school procedures. It is manifest in the othering which each group imposes on the other. The erection of barriers, whether they be prejudicial social and psychological stereotypes, limits on the access to appropriate courses and information, or essentialized views of "appropriate" interpretations and representations, separates the just plain folks from science and technology. The removal of these barriers cannot guarantee any increase in the number of persons electing scientific careers; none-the-less, the possibility of multiple forms of participation will be served.

References

Belland, J. C. (1985). The Inverse Tool Principle. Educational Communications and Technology Journal, 33 (1), 51-57.

Collis, B. (1985). Psychological implications of sex in attitudes toward computers: Results of a survey. International Journal of Women's Studies 8, 207-213.

Corea, G. (and 6 others). (1986). Man-Made Woman. Bloomington, IN: Indiana University Press.

Damarin, S. K. (1988). "The 'Women and Math Problem' in a Computer Era: Working toward Solutions." Eugene, OR: Center for the Study of Women and Society.

de Beauvoir, S. (1953). The Second Sex. New York: Alfred Knopf.

Frankenstein, M. (1987). Critical Mathematics Education: An Application of Paolo Freire's Epistemology. In I. Shor (Ed.), Freire in the Classroom (pp. 180-210). Portsmouth, NH: Heinemann.

Harding, S. (1986). The Science Question in Feminism. Ithaca, NY: Cornell University Press.

Hayles, N. K. (1990). Chaos Bound. Ithaca, NY: Cornell University Press.

hooks, b. (Gloria Watkins) (1990). Yearning. Boston, MA: South End Press.

Lindquist, M. (January 8, 1991) Lecture at The Ohio State University, Columbus, OH.

Nelkin, D. (1987). Selling Science. San Francisco: Freeman.

Papert, S. (1987). Technological thinking versus computer criticism. Educational Researcher ,16 (1), 22-30.

Paulos, J. A. (1988). Innumeracy. New York: Hill and Wang.

Schor, N. (1989). The essentialism which is not one: Coming to grips with Irigaray. Differences, 1 (2), pp. 38-58.

Snow, C. P. (1963). The Two Cultures. New York: Cambridge University Press.

Spivak, G. C. (Sarah Harasym, ed.) (1990). The Post-Colonial Critic. New York: Routledge.

Wenger, E. (1987). Artificial Intelligence and Tutoring Systems. Los Altos, CA: Morgan Kaufmann.

TECHNOLOGICAL PROGRESS: HOW OUTSIDERS SEE IT

Doris Z. Fleischer: Special Lecturer, Humanities Department
New Jersey Institute of Technology (NJIT)
323 Dr. Martin Luther King Jr. Boulevard
Newark, NJ 07102 201-596-2996

Lisa Novemsky: Coordinator, Center for Pre-College Programs
NJIT 201-596-5795

Phyllis Young Langford: Personnel Office
Trenton Board of Education
Trenton, NJ 08609 609-989-2886

Frieda Zames: Associate Professor, Mathematics Department
NJIT 201-596-2996

Ronald Gautreau: Professor, Physics Department
NJIT 201-596-3556

The primary function of the outsider's view in technology, as in most areas of life, is to open up possibilities that benefit all of society; however, these untapped potentialities are often unavailable to those steeped in orthodox modus operandi. For it is not so much by means of the accumulation of data that true wisdom is achieved, but rather new insights are the result of that piercing vision that stems from looking at phenomena from a new perspective. Frequently, it is the outsider, one who is not intellectually or emotionally invested in traditional protocols, who can offer challenging perceptions. In the world of technology, a variety of people may be considered outsiders, those who do not fit the generally accepted model of influential figures in the disciplines associated with the sciences.

A case in point, appearing recently on the front page of The New York Times (May 12, 1991) reveals the reaction to the inclusion of female, black, Hispanic and Asian workers into "jobs that were once the exclusive domain of white men" at Pacific Gas and Electric Company. Many white men found that "working with women and minority members is not so bad." In fact there were unanticipated advantages such as "the more democratic approaches to management" introduced by female and minority bosses (Section I, page 1). As one worker put it, before the policy for greater inclusion "everybody lived in a little box. You went through your day with blinders. You weren't allowed to go outside the box."

An example of the emergence of new options is presented by the female executive who "unlike the white male stereotype... goes, often running, to her subordinates' offices" instead of insisting that they accommodate her by coming to her office the moment she beckons. Another description of how this female executive does things differently from her male counterparts is offered by another one of her white, male employees:

> She has enough confidence to let go of things....I call her in the morning and say, 'Here's what I'm doing and here's why.' She'll say, 'Good luck. Let me know how it turned out.' Other bosses want more explanation, more details (Section I, page 20).

There does seem to be a change in attitudes in the white, male power structure at P. G. & E. One white, male manager described how incensed he was, originally, when a black candidate was recommended for a promotion, but then a colleague recalled that the prospective worker was "extremely sharp, a real people person...the sort workers want most." Even the white, male executives at the top of P. G. & E. may "truly intend to let the old order go." At least at this point they appear willing to reexamine "the conventions that had put them in power." Virgil G. Rose, a senior vice president overseeing the divisions, offered his observation of the risk-taking capacity of his new upper-echelon employees:

> What I've noticed is that several of the best divisions are run by women and minorities. They've taken a less traditional approach to managing. They're willing to make mistakes and feel O.K. about it (Section I, page 20).

All four presentations address issues relevant to groups often considered outside the world of science and technology: people with disabilities, racial and ethnic minorities, women, people who are intimidated by mathmatics. The first presenter, Frieda Zames, a physically disabled professor of mathematics at New Jersey Institute of Technology, offered a parable that illustrates the value of a broadening of perspective. There was much concern regarding the requirement for accessibility according to the 1977 regulations of Section 504 of the Rehabilitation Act of 1973. Shortly after Section 504 was signed, a small town made ramps on all its sidewalk corners for people in wheelchairs. People with shopping carts thought the ramps were for them; people with baby carriages thought the ramps were for them; bicyclists thought the ramps were for them; people with suitcases thought the ramps were for them; and pregnant women and older people thought the ramps were for them.

Accessibility helps almost everyone; yet, the struggle to obtain access often meets with fierce resistance. Three examples illustrate this point. First, a restaurant owner in NYC was forced to comply, against his will, to a newly enacted accessibility statute, Local Law 58 (LL58). Later, he wrote a letter to the enforcement agency that to his astonishment, after the restaurant was made accessible, business improved greatly.

Second, many universities assumed that the new regulations, necessitated by Section 504, would be a financial burden. Although some people at NJIT believed that the new regulations would be a waste of money and resources, the present administration recognized the necessity of providing access. As a result, grants and endowment funds eventually flowed, not only to disabled students, but to the Institute as a whole. Finally, three successful class action lawsuits, beginning in 1979 and settled in 1984, were filed against the Metropolitan Transportation Authority (MTA) of New York when it refused to comply with Section 504. Later, when almost all New York City buses had wheelchair lifts, not only did the MTA take credit for its accessible transit system, but the administration bragged about its accomplishment, for now it served as a model for other cities.

However, Zames pointed out that accessibility often is done incorrectly, even in major facilities. In a well-known hospital in New York City, she described being unable to get into a supposedly accessible bathroom because it was improperly designed. At a renowned university in New York City, she found that it was virtually impossible to obtain the key to the accessible bathroom. Interestingly, if disabled people were not thought of as "special" the remedy would be apparent--simply leave the bathroom unlocked and let everyone use it. Zames noted that few things are more frustrating than not being able to find a usable accessible bathroom when one desperately needs one. Even in the hotel in Washington, DC where the NASTS conference was held in 1991, it was a struggle to figure out the unnecessarily circuitous path, through back kitchens and storage areas, to traverse the accessible route to the plenary session. Furthermore, not even a simple aid like a map was available. The only way to make sure that physical and programmatic changes for people with disabilities are done appropriately is to get the correct information from disabled people themselves. The point is that Zames' experience is a reminder of the veracity of an all-too-frequently neglected precept: regardless of age, gender, or ethnicity, the community being served should be involved in decisions that affect it.

Returning to a personal note, Zames referred to the fact that technology to her means access to mobility, transportation, employment. Technology has made it possible for her to get around in a motorized scooter, to drive a car, and to use public transportation. For now most buses in New York City have lifts, and some subways and trains are accessible. Today there are telephones that are usable by deaf people, and soon telephone service will link deaf and hearing people all over the country. The phone company will finally comply with a 1934 federal law providing that telephone service be available to everyone in the United States. Thus technology has made assumptions about the limitations of certain groups of people anachronistic. For example, the fact that Zames cannot use a chalk board does not prevent her from teaching mathematics at an institute for higher learning because she can use an overhead projector. It took a lawsuit against the New York City Board of Education in the early 70's to overturn a ruling, based on a false preconceived notion, that disabled persons could not teach because they were fire hazards. Who can say how many potentially inspiring teachers were frustrated in their desire to become educators? Since the ruling was legally challenged and reversed, society has benefitted by allowing talented teachers to serve as role models to students, disabled as well as nondisabled, who need to learn by experience that obstacles can be overcome.

Another problem related to exclusion of specific groups was addressed by Phyllis Young Langford of the Trenton Board of Education as she discussed a study recently done by the National Science Association entitled, "Changing America: A New Face of Science and Engineering in the 80's and Beyond -- A Task Force on Minorities, Women and the Disabled in Science and Technology." Langford was primarily concerned with the subliminal effects of limited role models and the influence of culture in science education. She bemoaned the overly-Eurocentric slant in the curriculum, the lack of a multicultural point of view. "It is unfortunate with all talk about the Gulf War that it was scarcely mentioned that the inventor of the gas mask was a black man, Garrett Morgan." She went on to make reference to other black contributors to science and technology such as T. J. Marshall, inventor of the fire extinguisher; J. A. Burr, inventor of the lawnmower; and John Standard, inventor of the refrigerator. In addition, she pointed out that teaching strategies too often do not take into account differences in culture. To illustrate, Hispanics are commonly taught that it is a sign of respect to avoid looking an authority figure in the eye; Asians are frequently encouraged to avert calling attention to themselves in the classroom and questioning authority. These behavior patterns of Hispanics and Asians conflict with what is generally deemed praiseworthy by American society. Yet these students' deviation from the norm is not the result of being wrong; rather they have been nurtured in traditions different from those commonly practiced in the United States.

As Lisa Novemsky commented, Langford's insights recall Sheila Tobias' work, a paperback about introductory college science entitled, They're Not Dumb, They're Different. The book which spawned a great deal of response, including a lengthy article by Fred Hechinger in The New York Times, is strongly critical of the teaching of science: "We exhibit the worst kind of prejudice by structuring curriculum to select those students who resemble ourselves for success [sic]" (Research Corporation Bulletin, Fall/Winter 1990 - 1991, pp. 1-2). One group that clearly does not fit the mold is women. "From the narrow perspective of the modern industrialized West," David Noble indicates that "the entry of women into these fields [science/technology] appears to be an assault on tradition" ("A World Without Women: The Masculinization of Western Science and Technology", p. 1). Yet the increase of women into these disciplines is dramatic and destined to continue to rise. For example, degrees in computer and information science awarded to women increaed from 14.9% in 1973 to 36.3% in 1983 on the Bachelor level, and 10.6% in 1973 to 28.3% in 1983 on the Masters level. In engineering, degrees awarded to women increased from 1.2% in 1973 to 12.2% in 1983 on the Bachelor level, and 1.7% in 1973 to 9.3% in 1983 on the Masters level (although it is noteworthy that levels of undergraduate women enrolled in engineering programs has not increased since 1984). The title of a recent article in The New York Times (May 21, 1991, Section C, p. 1) "Women Swell Ranks of Science, But Remain Invisible at the Top," underscores the reality that discrimination is still apparent, especially at higher levels.

However, the attempt to foster the inclusion of women and minorities into the work force is not an act of altruism. Rather, it is becoming increasingly evident that without these groups, the work force in the United States will be inadequate. In addition, as with the disability community, many programs such as flex time, maternity (or paternity) leave, and day care, designed to make work feasible for women, benefit all society. A dramatic example is provided by a recent Supreme Court decision regarding whether women should be prevented from working in situations feared hazardous for a potential mother. It was determined that women could not be denied jobs just because they were of child-bearing age. For if work is deemed dangerous for a potential fetus, both male and female workers are probably at risk. Furthermore, strategies must be devised to include underrepresented groups who, heretofore, have felt alienated from the sciences.

Concurring with a geologists reaction to Tobias' work that "many scientists feel that only 'naturals' need apply to take courses" (Research Corporation Bulletin, Fall/Winter 1990 - 1991, p. 2), Ron Gautreau, a physics professor at NJIT, described a new technique for teaching physics to students who may be intimidated by mathematics. The new instructional method is called "Overview, Case Study Physics" (OCS Physics) and is now in its 4th year of development that started from a FIPSE grant by Dr. Alan Van Heuvelen at New Mexico State University.

Conventional physics instruction has for years assumed that students have little knowledge of physics. It was taken for granted that a clear presentation of the physical rules that guide our universe would simply fill the student's tableau rasa, and knowledge would be absorbed as given. After hundreds of studies, we now know that students have preconceptions that often conflict with the theories of physics. Ask a student to describe the ensuing motion of a body pushed off a horizontal tabletop. Far too many responses will be the "Roadrunner trajectory," where the body flies off horizontally, pauses for a moment, and then plummets straight down--just as what happens in the popular tv Roadrunner cartoons. Not only does OCS deal with these misconceptions directly, but the procedure reveals that the concepts of physics form a consistent and encompassing model of how our world really works.

In OCS physics new knowledge is introduced qualitatively using activities that confront preconceptions and that develop qualitative understanding of physics concepts. OCS learners first concentrate on physical concepts, without worrying about mathematics. To understand the quantities involved in describing motion, e.g., how the change in velocity (acceleration) is related to whether an object is speeding up or slowing down, learners construct motion diagrams showing in sketches the increase or decrease in an object's velocity. To get a feel for the various types of forces that can act on the body, students construct force diagrams showing the various forces. Learners then look at how forces affect motion, and they essentially find out that forces produce acceleration of bodies. In other words, they discover by themselves Newton's Second Law, F = ma.

In this overview, students learn to construct models of physics problems using sketches, graphs, and motion and force diagrams. Their understanding evolves in these pictorial models as they learn to reason without any math. Not until the students have gained confidence in their mastery of physical concepts is the necessary mathematics introduced.

When one seeks a modern approach to the issue of inclusion, ironically one is drawn to the nineteenth century social thinker, John Stuart Mill.

> In all things of any difficulty and importance, those who can do them well are fewer than the need, even with the most unrestricted latitude of choice: and any limitation of the field of selection deprives society of some chances of being served by the competent, without ever saving it from the incompetent (The Subjection of Women, Indianapolis: Hackett Publishing Company, 1988, p. 19).

With a prophetic voice, Mill calls to us across the years to inspire us to our ultimate goal--to transcend our commitment to the minority, feminist or disability community in order to unite in our overriding responsibility to one another as part of the human community. For Mill says limitations, restrictions, impositions on the potentiality of any group "dries up the principle fountain of human happiness and leaves the species less rich" (p. 109).

SEQUENCING THE HUMAN GENOME: A FEMINIST ASSESSMENT

Helen Bequaert Holmes, Ph.D.
24 Berkshire Terrace
Amherst, MA 01002
413-549-1226

Fundamental questioning of the Human Genome Initiative (HGI) has been rare. Indeed, most scientists believe, "You can't be against getting this information."[1] So, instead of debate over the HGI's basic goals, only a few questions have been raised about priorities in research and technology development or about how to apply the resulting knowledge in the clinic. Also missing is an explicit feminist analysis beyond generalized rumblings. Today I apply a method of feminist assessment of medical technologies to some issues of concern in the HGI.

A Feminist Methodology. Since feminists hold diverse positions,[2] the method I have devised may not be acceptable to all feminists. In my scheme, the assessor judges how the technology measures up to three queries, using a set of eight yardsticks to ferret out just how closely use or development of that technology approaches a positive answer to each query. These queries are not a set of principles to weigh against each other; they are not an utilitarian cost/benefit analysis. Today I discuss only one query:

I) Does the technology help to alleviate the oppression of powerless groups, liberate them, raise their status in society, and empower them?

And I mention only 4 of the 8 yardsticks:[3]

- Assess any risk/benefit or cost/benefit analysis that has been done, very specifically as: risks to whom, benefits to whom.
- Note whether the technology reinforces existing dualisms and/or creates new ones, e.g., makes the rich richer and the poor poorer, increases the gap between "first world" and "third world."
- Assess whether the technology makes individuals more dependent on impersonal systems, e.g., General Motors, medicine, the government.[4]
- Look for doublespeak in the language used, e.g., do words such as "choice" and "autonomy" actually mean the opposite?

A feminist assessing this complex project is faced with a formidable array of issues. Today I concentrate on the question of knowledge and power from that knowledge.

First, let's get clear about the stated ends or goals of the HGI -- the "justification" for making the HGI a national or global priority. Knowledge for knowledge's sake is one, but one goal that convinced Congress is that information gained can be applied to identification of and treatment of genetic diseases, followed by therapy of genes themselves and then the elimination of all genetic disease. Over the past 15 years, when some genes _have_ been located, or stretches of DNA _have_ been sequenced, attempts have usually been made to apply this information. Let us use lessons learned by that history.

Imperfect Genetic Data. Different methods sometimes assign the same gene to different spots on a chromosome or give different sequences of nucleotides (Stephens et al, 1990). Scientists rarely repeat expensive time-consuming procedures to check accuracy. Screening tests may then be developed from these inaccurate data, or from sequences of DNA _near_ a postulated gene (Holtzman, 1989). Pressures by health professionals, by patients, by employers, and by insurance companies that are put onto science, clinical genetics, and the pharmaceutical industry foster uncritical development of new diagnostics (Nolan & Swenson, 1989).

Competitiveness and then sometimes the compromising of scientific integrity (fraud, fixing up data, failing to check results) are endemic to all of science; they are not unique to gene mapping and sequencing. However, the stakes may be high in the HGI (Roberts, 1990). Information gained can subsequently be cheaply translated into commercial testing probes (for gene sequencers to use) and handy little kits for screening large numbers of neonates, or fetuses, or newly weds, or prospective employees. Most U.S. states mandate screening blood of all neonates for one or more genetic conditions.

Development of commercial genetic tests actually increases the gap between rich and poor, and the power imbalance between those who market the tests and the oppressed group: the people at risk for the defect measured. The benefits accrue to pharmaceutical firms and _possibly_ to the community if medical costs are reduced by not caring for the defectives (and _if_ the cost of testing is less than the cost of caring). But the risks accrue to the tested group. This is especially ironic because those developing the test honestly believe they are helping the tested community; patients themselves may even demand testing. Yet _individuals_ are rarely helped because usually no cure exists; the _group_ at risk is simply complicit in its own beneficent genocide. For example, for 30 years biologists have known the DNA difference between the gene for normal hemoglobin and its mutant for sickling hemoglobin. Manufacturers of test kits have benefitted, yet no effective therapy has been produced for those sick with anemia (Bishop & Waldholz, 1990; Duster, 1990; Wingerson, 1990). And carriers of _one_ sickling gene have often suffered unjustified discrimination in employment and insurance (Council, 1990; Duster, 1990).

The international competition in genome sequencing does not mollify these concerns. To quote David Kingsbury of the National Science Foundation, "It's not unreasonable to view this as part of an international race for control of the world pharmaceutical industry."[6] And probably _this_ is the goal that really convinced Congress.

Recent history of medical screening reveals that, even when based on accurate data, genetic (and other screening) tests have a (sometimes large) chance of error -- false negatives and false positives.[6] Reasons include operator errors in performing of tests and/or reading of results (reliability); manufacturer errors (validity); the probe matching a region near the actual gene, so that a crossover has moved the gene away from the probed region (giving a false positive, for the gene is not actually there); or a gene somewhere else causing the same disease (a false negative). Making test kits pays so well[7] that kits often get marketed before they are "perfected." One example is the test for alpha-fetoprotein in expectant mothers' blood: even dependable labs disagree with each other on results from the same sample (Sun, 1983).

False negatives and false positives cause human suffering and disempower. As one example, Tymstra (1986) interviewed mothers of children in The Netherlands who had falsely tested positive for hypothyroidism after birth. Even though the second, more careful, test gave their infants a clean bill of health, many mothers still believed something was wrong -- were terrified with every minor childhood illness. Test results, as it were, made healthy children sick (Holtzman, 1989; Sorenson et al, 1984).

A disturbing new trend in molecular genetics is the finding of genes that give predispositions (or susceptibilities or propensities) to a disease or other condition. Now being tracked, for example, are predispositions to such conditions as colon cancer, schizophrenia, manic depression, alcoholism, and criminal behavior (Bishop & Waldholz, 1989). I don't mention the predisposition to homelessness (Koshland, 1989).

Figure 1 shows possible results of an imperfect test for a genetic predisposition. I build this semi-hypothetical example from the work of Blum and colleagues (1990) who have found a region on chromosome 11 with a gene, that, if defective, may predispose its carriers to alcoholism. Using autopsy brain tissue from 35 severe alcoholics and from 35 nonalcoholics, they found the A1 version of the D2 receptor gene in 69% of the alcoholics and in 20% of the nonalcoholics. Just to build my case, let us assume that all of the alcoholics had the A1 gene, but the test didn't find it, i.e., 31% false negatives; let us further assume for the sake of the argument that the 20% nonalcoholics who tested for the gene were false positives. For convenience in calculation, I have designed Figure 1 under the assumptions that an entrepreneur has developed a test from Blum's work[8] and that 10% of a population of 1000 carries the predisposition gene. Note that 180 persons who do not have the gene will test positive and 31 with the gene will test negative. I have ignored possible environmental factors. For example, the 180 persons may actually have the A1 gene, but never drink and so aren't alcoholics.

Figure 1.

GENE GIVING PREDISPOSITION TO ALCOHOLISM

Assuming a population of 1000
Assuming 10 % of population have the gene

	actually have gene	do not have gene	percentage false
test positive	69*	180*	72% of the 249 are false
test negative	31*	720*	4% of the 751 are false
TOTALS	100	900	21.1% of the 1000 are false

* based on data from Blum et al. (1990), in which 69% of alcoholics tested positive for the A1 allele of the dopamine D2 receptor gene and 20% of nonalcoholics tested positive.

Certainly false information can never empower. In nonmedical situations, false positives suffer; for example, they may be denied employment and/or insurance. In medical situations, false negatives suffer, in that they don't get treatment (Nelkin & Tancredi, 1989).

Correct Genetic Knowledge and Power. But does correct genetic knowledge empower? Although society may benefit expending fewer resources on health care and some genetically marked individuals may benefit in being able to make life plans, yet the truth may not be liberating. As Robin Henig (1989) put it, "Do we really want to know. . . the most likely cause of our own death?" Henig, whose father has genetic polycystic kidney disease, has herself not taken the test. The feminist analyst must take an uncompromising look at knowledge as power. Where is the power in the "fact" of a genetic diagnosis? Power resides, first, in the sequencers, who may or may not have found the correct sequence; next, in the developers of the test; next, in the deployers of the test; fourth, in the purveyors of the information (genetic counselor or physician) to the client (person at risk); and little remains for the client. How is this knowledge power? Look at the genetic counselor. In conscientious genetic counseling, major "principles" of bioethics -- benevolence, kind paternalism, autonomy, justice -- function as filters of truth.[7] For the counselor controls the information and uses these principles in deciding how much information will be given to the client and in what way. Figure 2 depicts the filtering process through which genetic information passes.

Figure 2.

INFORMATION FILTER-THROUGH

- **ACTUAL DNA SEQUENCE**
  - **DNA SEQUENCE AS DETERMINED (accuracy)**
    - **TEST CREATED BY DEVELOPER (validity)**
      - **TEST RESULTS FROM DEPLOYER (reliability)**
        - **RESULTS RELAYED BY COUNSELOR (paternalism)**
          - **CLIENT**

Let's look at power in prenatal testing. To women, this testing and counseling are presented as offering them a "choice," the choice not to be burdened with a handicapped child. Yet the word "choice" here is doublespeak. First, in the United States, such choice is class-dependent (Fletcher & Wertz, 1990; Wright, 1990). Since poor women under Medicaid in most places cannot get abortions, they are usually not offered the tests. Then, middle-class women essentially are forced to be tested because they may later be denied health insurance or prosecuted for "child abuse." Finally, a woman may "choose" to abort a much-wanted pregnancy because she knows no community support exists for a child with that handicap. If only poor women end up raising children with testable genetic conditions, the stigma and the financial gap between rich and poor will widen.

The Concept of Normalcy. Bentley Glass (1974) has argued that humans have a paramount right to be born with a normal, adequate hereditary endowment. How blithely we use the word "normal." Does any human have either the ability or the right to judge what is normal? Yet any search for genes entails a concept of normalcy. Many women live afraid of not being normal.

Now, imagine a world populated only by "normal" people. Mediocrity in all areas -- the arts, science, government, mathematics -- is likely. Who can best contribute to making the good society? Should we abort an Abraham Lincoln for Marfan's syndrome? Should we abort a Beethoven because of genetic deafness? An Einstein for a predisposition to dyslexia?

In conclusion, let's look at concepts of the good life. Part of living the good life is struggling to meet challenges, to overcome obstacles, and to strive for good. Should we use knowledge of someone else's DNA to eliminate that 'other' whose genes fail to meet our criteria of normalcy -- are we entitled to judge that such a person would fail to surmount the challenges of life? Fetuses eliminated by genetic screening are not yet persons, but we do indeed judge whether, if they do become persons, they will not be able to, or ought not be allowed to try to, live the good life. We then propose beneficent genocide -- getting rid of the disabled for their own good.

We exercise freedom -- human mastery carried out in the name of beneficence -- but this way of exercising human freedom may actually be destructive of our own humanity (Meilaender, 1990).

Looking back at the query, I am forced to conclude that most uses of information from the HGI will not foster a positive answer. Setting back its goals seems by far the more likely outcome.

NOTES

1. Charles Cantor, quoted in Roberts (1988).

2. I define "feminism" as the belief that women have been oppressed and continue to be oppressed; that this oppression is wrong; and that one should work to end it. Differences among feminists come from differing beliefs about sources of oppression and about the courses of action to take. (Feminists are not necessarily female -- there are male feminists, and certainly not all females are feminists.) My definition of "oppression" includes exploitation, marginalization, powerlessness, cultural imperialism, and violence, as clearly delineated by Young (1988).

3. In developing these yardsticks, I am indebted to and inspired by Culpepper (1981).

4. For the first and third yardsticks, I have been influenced by Koch and Morgall (1987).

5. Quoted in Kanigel (1987), p. 99.

6. For excellent detailed discussions of biological test reliability, see chapter 3 in Nelkin and Tancredi (1989) and chapter 5 in Holtzman (1989).

7. Holtzman (1989) might disagree; in a project funded by the Office of Technology Assessment, he sent questionnaires to biotechnology companies that were or had been constructing human DNA probes. He concluded that, "No company has yet demonstrated the profitability of DNA-based tests (p. 124)," and, the "technology is still cumbersome (p. 126)."

8. Using as an example a test that detects only 69% of the carriers is not unrealistic. A recent proposed test for cystic fibrosis, seriously being considered for screening all white caucasians of reproductive age, identifies only 70% of the carriers of one cystic fibrosis gene. For arguments to use the test, see Brock (1990); for arguments against, see Gilbert (1990); see also Wilford and Fost (1990).

9. For genetic counselors' use of these principles in perplexing cases involving DNA tests for Huntington disease, see Huggins et al (1990) and Chapman's (1990) commentary on their work.

REFERENCES

Bishop, J.E., & Waldholz, M. (1990). Genome: The story of the most astonishing scientific adventure of our time -- The attempt to map all the genes in the human body. New York: Simon & Schuster.

Blum, K., Noble, E. P., Sheridan, P. J., et al. (1990). Allelic association of human dopamine D2 receptor gene in alcoholism. Journal of the American Medical Association, 263, 2055-2060.

Brock, D. (1990). Population screening for cystic fibrosis. American Journal of Human Genetics, 47, 164-165.

Chapman, M. (1990). Predictive testing for adult-onset genetic diseases: Ethical and legal implications of the use of linkage analysis for Huntington disease. American Journal of Human Genetics, 47, 1-3.

Council for Responsible Genetics. (1990). Position paper on genetic discrimination. GeneWATCH, 6(4-5), 3-6.

Culpepper, E. E. (1981). Uncovering patriarchal agendas and exploring woman-oriented values. In H. B. Holmes, B. B. Hoskins, & M. Gross (Eds.), The custom-made child? Women-centered perspectives (pp. 301-310). Clifton, NJ: Humana.

Duster, T. (1990). Backdoor to eugenics. New York: Routledge.

Fletcher, J. C., & Wertz, D. C. (1990). Ethics, law, and medical genetics: After the human genome is mapped. Emory Law Journal 39, 747-810.

Gilbert, F. (1990). Is population screening for cystic fibrosis appropriate now? American Journal of Human Genetics 46, 394-395.

Glass, B. (1974). Ethical problems raised by genetics. In C. Birch & P. Abrecht (Eds.), Genetics and the quality of life (pp. 51-57). New York: Pergamon.

Henig, R. M. (1989, December 24). High-tech fortunetelling. The New York Times Magazine, pp. 20, 22.

Holtzman, N. A. (1989). Proceed with Caution: Predicting genetic risks in the recombinant DNA era. Baltimore: Johns Hopkins.

Huggins, M., Bloch, M., Kanani, S. et al. (1990). Ethical and legal dilemmas arising during predictive testing for adult-onset disease: The experience of Huntington disease. American Journal of Human Genetics, 47, 4-12.

Kanigel, R. (1987, December 13). The genome project. The New York Times Magazine, pp. 98-101, 106.

Koch, L., & Morgall, J. (1987). Towards a feminist assessment of reproductive technology. Acta Sociologica 30, 173-191.

Koshland, D. E., Jr. (1989). Sequences and consequences of the human genome. Science, 246, 189.

Meilaender, G. (1990, October 3). Mastering our gen(i)es: When do we say no? The Christian Century, pp. 872-875.

Nelkin, D., & Tancredi, L. (1989). Dangerous diagnostics: The social power of biological information. New York: Basic Books.

Nolan, K., & Swenson, S. (1988). New tools, new dilemmas: Genetic frontiers. The Hastings Center Report, 18(5), 40-46.

Roberts, L. (1988). Academy backs genome project. Science, 239, 725-726.

Stephens, J. C., Cavanaugh, M. L., Gradie, M. I., Mador, M. L., & Kidd, K. K. (1990). Mapping the human genome: Current status. Science, 250, 237-244.

Sorenson, J. R., Levy, H. L., Mangione, T. W., & Sepe, S. J. (1984). Parental response to repeat testing of infants with "false positive" results in a newborn screening program. Pediatrics, 73, 183-187.

Sun, M. (1983). FDA draws criticism on prenatal test. Science, 234, 1656-1657

Tymstra, Tj. (1986). False positive results in screening tests: Experiences of parents of children screened for congenital hypothyroidism. Family Practice, 3, 92-96.

Wilford, B. S., & Fost, N. (1990). The cystic fibrosis gene: Medical and social implications for heterozygote detection. Journal of the American Medical Association, 263, 2777-2783.

Wingerson, L. (1990). Mapping our genes. New York: Dutton.

Wright, R. (1990, July 9). Achilles helix. The New Republic, 203, 21-31.

Young, I. M. (1988). Five faces of oppression. Philosophical Forum, 19, 270-290.

VALUES IN ECOFEMINISM AND CREATION-CENTERED SPIRITUALITY: THE DIFFERENCE THEY MAKE IN POLICY MAKING

Barbara Anne Radtke, Emmanuel College, 400 The Fenway, Boston, MA 02115

In this paper I explore the values which are inherent in two movements which flowered in the beginning of the 1980s: ecofeminism and creation-centered spirituality. Both movements have indefinite boundaries and bodies of literature. For the purpose of this essay, I rely on the work of Ynestra King and the authors which appear in Judith Plant's anthology *Healing the Wounds: The Promise of Ecofeminism* for the framework of ecofeminism and on Matthew Fox's seminal work in creation-centered spirituality *Original Blessing*. While it is the claim of this paper that both ecofeminism and creation-centered spirituality share values in common, one must understand that they are phenomena with separate origins and different lives. Ecofeminism's roots are in ecological activism, feminist politics, and feminist theory. Creation-centered spirituality is rooted in Christian theology, ethics, ritual, and spirituality although it illustrates an awareness of spiritualities from various religious traditions and feels free to draw on them. It shares a kindred spirit with other explorers of religious studies such as Starhawk who refers to an earth-based spirituality in her work, Thomas Berry who refers to himself as a geologian, and Sallie McFague who has explored theological models for an ecological and nuclear age.

There are points of intersection between creation-centered spirituality and ecofeminism. They share the legacy of many of the same authors. Writers such as Susan Griffin, Rosemary Radford Ruether, Starhawk, and Mary Daly are referenced by both. Some ecofeminists like King claim a spiritual dimension to their lives and their work through ecofeminism and have used the term "ecofeminist spirituality." While a study of such commonalities and differences would be interesting in itself, I will not concentrate on a comparison of the theories/ theologies/ spiritualities but will identify the values they hold and how those values could influence technological assessment and policy. I foresee three areas that will be affected: 1) who is included in doing the assessment or policy-making, 2) what categories of evaluation and what kinds of questions are asked, and 3) the evaluation of the desirability of proposed solutions.

Ecofeminism

"What happens to women happens to the earth." This sentence, uttered by a colleague, was my first acquaintance with ecofeminism. Patriarchy has equated women and the earth in its ideology and both have been oppressed and used for the benefit of the patriarchs. Ecofeminism, in its broadest conception, is the theory and praxis which holds that "the oppression of women, racism, economic exploitation and the ecological crisis are all interconnected (King, 1990, cover)." It has emerged as a praxis or a politics to reverse this oppression through the dismantling or transformation of oppressive structures.

Someone like Anne Cameron in her essay "First Mother and the Rainbow Children" finds the manufacture of a new term "ecofeminism" insulting to long established feminism because she maintains that feminism has always embraced concern for other marginalized and non-elitist humans and non-humans (Cameron, 1989, p. 64-65). Most authors addressing ecofeminism agree, however, that it did indeed have a separate birth, emerging around the mid 1970s as a conscious effort to apply feminist principles of analysis about human relationships to human/non-human ones. As Charlene Spretnak has explained, some travelled a path of ecological concern and began to make links with women's issues; others journeyed in an orbit of women's concerns, particularly radical/ cultural feminist thought and nature-based religion, and eventually began to make the connection with ecology (Spretnak, 1988, p. 7).

According to Ynestra King, one of the chief builders if not the architect for the movement, ecofeminism claims four basic principles within which are embedded its fundamental values:

> 1. The building of Western industrial civilization in opposition to nature interacts dialectically with and reinforces the subjugation of women, because women are believed to be closer to nature. Therefore, ecofeminists take on the life struggles of all of nature as our own.
>
> 2. Life on earth is an interconnected web not a hierarchy. ....Therefore, ecofeminist theory seeks to show the connections between all forms of domination, including domination of nonhuman nature, and ecofeminist practice is necessarily antihierarchical.
>
> 3. A healthy, balanced ecosystem, including human and nonhuman inhabitants, must maintain diversity. ...
>
> 4. The survival of the species necessitates a renewed understanding of our relationship to nature, of our own bodily nature, and of non-human nature around us; it necessitates a challenging of the nature-culture dualism and a corresponding radical restructuring of human society according to feminist and ecological principles. (King, 1983, p. 119-120)

On its theoretical level, ecofeminism calls for, in the words of Rosemary Radford Ruether, "a conversion of our intelligence to the earth" (Ruether, 1989, p. 148). It rejects "the other," dichotomous thinking, and hierarchies--all of which are related. The understanding of "the other" is a basic insight of the early feminist Simone De Beauvoir who offered in her philosophy an analysis of the treatment of women in society based upon their being "the other." "The other" becomes the adversary of the self, a projection of all that is unacceptable or rejected about the self, easily applied to genders, races, classes, ethnic groups, species, or hemispheres. As women are "the other," so is nature, the poor, people of color, the East, the South, or the Middle East. This conceptualization of "the other" produces dualistic thinking, e.g., masculine/feminine, East/West, North/ South or first and second world/ third world, white people/ people of color. The establishment of these dichotomies always leads to their hierarchization, a situation of domination where one group is superior and the other is feared, stereotyped, and oppressed. As Ynestra King notes, "the domination of sex, race, and class and the domination of nature are mutually reinforcing "(King, 1983, p. 120).

While ecofeminism rejects dualism and hierachies, it values harmony within the interconnectedness of life, sometimes called the web of life. It treasures the diversity among nature and peoples and resists attempts to homogenize the differences while celebrating any progress toward an ultimate goal of harmony. It moves from a hierarchization to a new paradigm which has compassion as its essence (Plant, 1989, p. 1). It calls for a shift from a necrophilic praxis including militarism to a transformative, biophilic action.

Ecofeminism advocates a re-thinking of power, shifting from a concept of "power over" to the idea of "power-from-within." Starhawk describes the "power over" as the power of domination which is manipulative, controlling, and punishing. She describe the "power-from-within" as a personal power which leads to individual and community responsibility . She implies that "power over" is limited and therefore an object of competition while " 'power-from-within' is not limited and there is no scarcity of it in the universe. My power does not preclude your having power, rather my skills and knowledge may augment your own" (Starhawk, 1989, p. 177).

There are two major dualisms rejected by ecofeminists that deserve attention here: the culture/nature dichotomy and the thought/feeling, rational/non-rational dichotomies. In 1974, Sherry Ortner wrote an essay in which she analyzed the dichotomy between "culture" and "nature," conceptually dualistic constructs for understanding reality. Hester Eisenstein summarized part of Ortner's findings: "In the distinction between 'culture' and 'nature,' . . . 'culture' was seen not only as separate from, but as superior to, 'nature,' because of its ability to control and transform the natural environment "(Eisenstein, 1983, p. 22). Ortner further identified that women were considered closer to nature and men were associated with culture. Feminists have debated this relationship to nature. King gives two positions on the subject which have occurred repeatedly in theoretical developments: the advocacy of an alliance with culture while relinquishing the woman-nature identification and the advocacy of even a further identification of nature. King believes that ecofeminism offers an option for moving beyond this stalemate. "The liberation of women is to be found neither in severing all connections that root us in nature nor in believing ourselves to be more natural than men. Both of these positions are unwittingly complicit with nature/ culture dualism "(King, 1990, p. 7). King advocates using the woman-nature connection "as a vantage point for creating a different kind of culture and politics that would integrate intuitive, spiritual, and rational forms of knowledge" (King,1983, p. 123).

Ecofeminists also hope to undo epistemological dichotomies such as thought/ feeling. They seek to create new ways of understanding knowing and knowledge which employ emotion as well as reason. This epistemological investigation challenges the priority and the trust given to a knowledge which is termed rational, objective, neutral and linear. This suspicion therefore casts doubt on a nearly sacred way of describing the results which flow from science. However, as far as I can tell, ecofeminism does not intend to set itself up as anti-scientific but to raise questions about the nature of science itself so that science too can be reconceived as a non-dualistic enterprise. Rosemary Radford Ruether, a feminist theologian, has posed her concerns for science about the possible hazards of an inadequate epistemology:

> What we must now realize is that the patterns of rationality of left-brain specialization are, in many ways, ecologically dysfunctional. Far from this rationality being the mental counterpart of "natural law," it screens out much of reality as "irrelevant" to science and reduces scientific knowledge to a narrow spectrum fitted to dominance and control. But the systems it sets up are ecologically dysfunctional because they fail to see the larger relational patterns within which particular "facts" stand. This rationality tends toward monolithic systems of use of nature. ....
>
> Linear thinking simplifies, dichotomizes, focuses on parts, and fails to see the larger relationality and interdependence. Ecological thinking demands a different kind of rationality, one that integrates left-brain linear thought and right-brain spatial and relational thought. (Ruether, 1989, p. 148)

Rachel L. Bagby, in her article "Building the Green Movement," offers a description of ecofeminism which provides an excellent summary of the items which have concerned us in this section:

> Eco-feminism names patriarchy, with its cultural ethics of separation, control, dominance, hierarchical structure, and suppression of emotions and other

> nonquantifiable aspects of being, as the root cause of our present ecological and social crisis. It notes that the domination of nature is rooted in the domination of person over person, male over female, me over not-me. . . .
>
> As an alternative . . . eco-feminism advocates participatory modes of interacting. It is inclusive -mind, body, spirit, and emotions, inner and outer development, individual and social responsibility. (Bagby, 1988, p. 15)

Creation-Centered Spirituality

Matthew Fox bases his work in spirituality on the retrieval of the thread of creation which is woven through the history of Christian thought. Ongoing birth is a major metaphor for this spiritual process. The journey of creation spirituality wends its way through four related, spiraling paths in which interconnectedness not domination, biophilia not necrophilia, creativity and artistry not destruction and militarism, dialectic not dualist thinking are prized. Unlike most ecofeminist writers, notwithstanding Ruether, Fox's work employs major themes and terms of Christian thought. He maintains that God's original blessing and the on-going gift of creation are prior to the doctrines of original sin and redemption. If placed first, creation and blessing with its vision of justice, harmony, and beauty re-situate God and renovate the definitions of sin and salvation. In *Original Blessing*, from which quotations in this section are taken, Fox emphasizes God's immanence which is made known through creation--"God is in everything and everything is in God "(90). Salvation becomes the healing of injustice which is "a rupture in the order, harmony, balance and survival of the universe" (295).

Interdependence is core to relationships. "Wherever dependence reigns instead of interdependence, healing is in order"(287). Genuine interdependence is basic to a consciousness which is compassionate. Compassion, a key value to Fox, mandates equality. Fox bemoans that compassion as a relationship among equals has been overturned in favor of a definition and a mentality which fosters superior/inferior relations. "This reduction of compassion to dualistic, philanthropic, sentimental, and indeed sadomasochistic relationships tells us much more about culture at the same time that it leaves us ignorant about compassion" (278-79). One must enter into compassion and work to create or renovate existing human institutions "that themselves relate interdependently and encourage interdependent relationships" (281).

Fox rejects dualistic thinking as harmful to creative processes and the ongoingness of creation itself, which he terms cosmogenesis. He particularly eschews the dichotomies of carnal/ spiritual, heaven/earth, and subject/object. Dualism forces us into false either/or alternatives. Fox relates dualism and sin by identifying "...the sin behind sin as dualism or separation "(210). While Fox does not use the word "hierarchy," he does address dominance, power, and control. "Dualism wants to control conflict, to deny tension and difference. And in the process of such denial nothing is born" (211). He specifies ecological sin as dominated by a consciousness "that treats other creatures in a subject/object fashion of manipulation and control" (119). In general, he rejects a power structure of a dominant political group, "white heterosexual males, usually economically privileged," who set themselves up as the standard for what is and is not natural--what is or is not of creation (269).

Fox does not discuss power at length although an analysis of power is implied in his work. He rejects "power over," the power to manipulate and control. What replaces power of control is the power of fertility. This term resonates with his emphasis on the birth metaphor. It also appears to celebrate women. Fox indeed draws on women throughout history and contemporary feminists to help frame his argument. He states that feminists are "the principle group today who are recovering and recreating the creation-centered spiritual tradition "(271). He links women with the *anawim*, the oppressed in society.

Fox addresses the relationship between science and religion. He regrets the separation which has deep roots from the time of Augustine's work and which has experienced a widening gap since the seventeenth century. Relying on Michael Polanyi, Fox thinks Augustine's mistrust of nature inclined him to follow the fall/redemption path in theology and also led to a dismissal of science. This turn was influential in the relationship between science and religion/ spirituality throughout history. Thus through the recovery of nature as a source of wisdom for spirituality, an opportunity arises for a healing between science and spirituality. The following quotation illustrates what Fox thinks can be recaptured:

> To recover a spiritual tradition in which creation and the study of creation matters would be to inaugurate new possibilities between spirituality and science that would shape the paradigms for culture, its institutions, its people. . . . [W]hat might happen if science and religious traditions agreed to birth together instead of ignoring, fighting, or rejecting one another? Is not recovering a creation-centered spirituality recovering two sources of wisdom at once, that of nature via science and that of nature via religious traditions? (11-12)

Fox sees the failure of letting go, the denial of imagination, the poisoning of play with video war games, and the investment in patriarchal images of manhood all responsible for a militarism which he denounces.' In his second path of creation spirituality, Via Negativa, Fox discusses emptiness and emptying, silence and pain, and nothingness as sources of birth and ecstasy. These are necessary components, however uninvited into our lives, in the process of creation and creativity. Within creation spirituality, sin is the refusal to let go. In the case of militarism, Fox cites the failure of "the letting go of crazy military projections and nuclear madnesses; .... of narrow and parochial political systems and unjust economic systems" (166). In place of imagination, we have substituted a mentality of dominance (189). Fox ventures an association of manhood with armaments, the failure to renounce arms would be "the abandonment of malehood" (238), obviously the patriarchal interpretation of the gender.

In creation-centered spirituality, creation and its on-going nature are our original blessing. We have grown away from the celebration of that blessing with its focus on interconnectedness, harmony, justice, and beauty. The task at hand is to discover anew biophilic values and actions. The quest is critical because of the ecological and nuclear crises which are present at this point in history. This recovery process is assisted by dialectic rather than dualistic thinking, the re-acquaintance of science and religion in the quest for wisdom, and the embrace of a creative, non-violent path to solving the crises which face us.

It is clear that ecofeminism and creation-centered spirituality as espoused by Fox have much in common. They both value interconnectedness, harmony, diversity, and compassion. They reject dualistic thinking and power which means control and domination. They invite new relationships between knowing, knowledge, and fields of knowledge like science and religion.

Fox and ecofeminists also have differences. While Fox values the interconnectedness of life, the ecofeminists are sharper in their description and felt interpretation of the web of life. The ecofeminists emphasize more strongly "the other" as the analytical root of much domination and develop how thinking about "the other" leads to hierarchies. Fox does not elaborate on "the other." Ecofeminists also acknowledge and discuss the implications of the link made between women and nature, stressing more the relationship between what happens to women and what happens to the earth. It is not clear in *Original Blessing* if Fox grasps the way in which women's relationship with nature has been used in the ideology of their oppression. Thus it is ambiguous if his birth metaphors flow from a feminist perspective or are a part of the "eternal feminine," a meta-image which patriarchy has served up to women as the measure of a womanhood they are bound never to achieve. On the other hand, Fox's connection of harmony, beauty, and justice is helpful in gaining some understanding of how to reach harmony while honoring diversity. Fox's work is also helpful in understanding what fuels a militaristic mindset but he does not link overtly militarism and the oppression of women, a connection which can be made with ecofeminist analysis.

Given this brief comparison, we can say that the values inherent in both the movements can be summarized as honoring the interconnectedness and the web of life, particularly the connection between what happens to women and what happens to the earth. Harmony with the diversity of life is valued along with compassion for "the other" as a key to attaining the justice necessary for harmony. Dualistic thinking is highly suspect for leading to paradigms of dominance and "power over."

Implications for Policy-Making and Technological Assessment

Investment in and application of ecofeminist and creation-centered spirituality will lead to changes in policy-making and technological assessment. Allow me to offer six broad possibilities which flow from ecofeminism and creation-center spirituality. I am sure, if the movements grow and capture the imaginations and hearts of people weary of the world as the dominant culture views it , many more will emerge.

1. Any policy-making or assessment group will be inclusive--more so even than groups who would describe themselves as inclusive today. It is not easy to be inclusive. Persons who have been excluded from policy-making and assessment have become invisible. They and the concerns they represent have been erased, ignored, or considered fringe. Therefore training in a new way to imagine inclusivity is necessary. People will gain skills and seek the assistance of persons who have the skill to evaluate the boundaries of current inclusivity and push them further.

2. Exercises in inclusivity will happen before anyone defines the problem or its boundaries. The perception of the situation changes with the inclusion of a variety of viewpoints. There will be many more ways to define a"problem" or describe a situation if the diversity which ecofeminists and creation-centered spirituality thinkers value is employed.

3. A process for determining policy and assessment will be employed which insures that people can see each other "eye-to-eye" and have an equal chance for sharing their point of view and having it truly heard. There will be a break-down of the expert/non-expert dichotomy. There will not be some people who speak and some who listen but all will share and be heard. Different types of decision-making, like consensus building, will be used. There will be a decentralization of the decision-making process, with grassroots groups hosting various meetings in the process of decision-making. Power will also be decentralized.

4. Fragmentation and non-coordination can come with decentralization. People will arise who will be connectors between grassroots and/or regional groups. These people will be valued in society like specialists are now. Along with those who have talents for coordination in the management fields will be artists and various wise persons who have the vision to see the interconnections and/or bring people together. Therefore, a new role for the artist will arise.

5. Evidence or observation submitted to shed light on a situation may look different from an academic statement but will have its own authority. Poem, narrative, dramatic action, or role play will have an equal footing with statistics and projection charts. Open mindedness and suspension of judgement will be essential to undoing very narrow boundaries for what we have come to believe is "fact" and therefore admissible as a component to shape the "true picture."

6. Assessment and policy will be based on different types of questions of costs and benefits. It will be asked who will bear the greatest burdens not only in regard to finances but also in reference to customs, traditions, neighborhoods, livelihoods, trades and crafts, recreation, and family relationships. Analysis of cost would be made taking race, class, gender, ethnic, religious, geographic, and species considerations into account. As diversity in nature becomes more valued, we can expect to see preservation of different species and inorganic materials as an integral consideration. Beauty and harmony with the landscape will also be factors taken into account. Because the persons contributing to the policy will be more diverse and because representatives from the groups who potentially would bear the most burden will be part of the decision-making, the costs and benefits involved in the solution chosen will be more equitable.

NOTE: Matthew Fox's latest work *Creation Spirituality* was not yet published when this article was submitted.

References

Bagby, R. L. (1988, Spring). Building the Green Movement. Women of Power, 9 , pp. 11-17.

Cameron, A. (1989). First mother and the rainbow children. In J. Plant (Ed.), Healing the wounds: The promise of ecofeminism (pp. 54-66). Philadelphia: New Society Publishers.

Eisenstein, H. (1983). Contemporary feminist thought. Boston: G.K. Hall.

Fox, M. (1983). Original blessing. Santa Fe: Bear & Company.

Fox, M. (1991). Creation spirituality: Liberating gifts for the peoples of the earth. San Francisco: Harper.

King, Y. (1983). Toward an ecological feminism and a feminist ecology. In J. Rothschild (Ed.), Machina ex dea (pp.118-129). New York: Pergamon Press. Reprinted in 1989 as The ecology of feminism & feminism of ecology. In J. Plant (Ed,), Healing the wounds: The promise of ecofeminism (pp. 18-28). Philadelphia: New Society Publishers; and in 1990 in What is ecofeminism? (pp. 25-36). New York: Ecofeminist Resources.

King, Y. (1990). What is ecofeminism? New York: Ecofeminist Resources.

Ortner, S. (1974). Is female to male as nature is to culture?" In M. Z. Rosaldo and L. Lamphere (Eds.), Women, Culture, and Society (pp. 67-87). Stanford: Stanford University Press.

Plant, J. (Ed.). (1989). Healing the wounds: The promise of ecofeminism. Philadelphia: New Society Publishers.

Ruether, R. R. (1989). Toward an ecological-feminist theology of nature. In J. Plant (Ed.), Healing the wounds: The promise of ecofeminism (pp. 145-150). Philadelphia: New Society Publishers.

Spretnak, C. (1988, Spring). Ecofeminism: our roots and flowering. Women of Power, 9 , pp. 6-10.

Starhawk. (1989). Feminist, earth-based spirituality and ecofeminism. In J. Plant (Ed.), Healing the wounds: The promise of ecofeminism. (pp. 174-185). Philadelphia: New Society Publishers.

GIRL'S PLAY, WOMAN'S WORK

(The title was suggested by an exhibition of girls' toys (1985) sponsored by the Goldstein Gallery, Univ. of Minnesota, curated by Timothy Trent Blade.)

Sandra A. Brick
Science Museum of Minnesota, St. Paul, MN 55101

Fred M. Amram
General College, Univ. of MN, Mpls., MN, 55455

Mary Ellen Gee
General College, Univ. of MN, Mpls., MN, 55455

Girl's play teaches woman's work. Dolls and their accessories provide role models and define woman's place in society. One advertisement suggests:

> Sewing is a practical skill . . . that mothers have enjoyed sharing with their daughters. Carry on this tradition as the two of you make doll clothes for Kirsten, Samantha, and Molly (The American Girls Collection, 1990).

This paper provides playful options that permit popular dolls (e. g., Kirsten, Samantha, Molly, and Barbie) to provide new, and more diverse, role models for girls. With appropriate accessories, dolls can even teach inventing skills. Via dolls and stories, girls can fantasize a new womanhood.

The Problem

One important aspect of the women's movement is a recognition, even a celebration, of women's creativity. The new National Museum of Women in the Arts highlights women artists. Serious orchestras are playing music by women composers (e.g., Joan Tower, Thea Musgrave, and Libby Larsen). Women novelists (e.g., Amy Tan, Louise Erdrich, and Alice Walker) and poets (Carol Bly, Patricia Hampl, and Jill Breckenridge) are finally receiving awards and achieving market success.

Art, music, fiction, poetry--all are important contributions to culture. None, however, has quite the "change agent" power of technological innovation. None has the impact of technical invention on the way we live. Our material culture determines our life style and, in fact, our art. Yet as recently as 1988, only 5.5% of U.S. patents granted to Americans included the name of a woman (U.S. Department of Commerce, 1990). No women have yet been inducted into the National Inventors Hall of Fame, although several have become Nobel Laureates. By way of example, Gertrude Elion's name appears on 45 patents and over 280 scientific publications, which reflect her many drug discoveries. She developed the earliest active agents against leukemia, which led to the drugs that today are achieving 80% cure rates. Another discovery blocked the immune response that triggers rejection of foreign tissue, a drug that was immediately applied to successful kidney transplants. She also developed an anti-herpes agent and participated in developing treatments for gout.

Inventing is a statement of power! Women's powerlessness, however, has been taught as a cultural paradigm and occasionally girls are clearly and specifically taught that inventing is inappropriate behavior. In a 1970 children's book, a little boy is shown tinkering with tools and scraps. In a second illustration, a girl sits in a chair under a lamp clearly "jerry-built" by the little boy. The caption under the first picture is "Boys invent things." Under the second picture the caption reads "Girls use what boys invent" (Darrow, 1970).

The Impact of Play

> The most creative role of doll--or bear--play is in developing the relationship between the child and the adult world (Einon, 1985).

The child creates, and responds to, situations as the parent or teacher does and "in doing so, she investigates what it is like to feel and act as you do." In other words, the child rehearses adulthood with the parent or teacher as model and the doll as a symbolic representative of self. We note that Einon refers to the user of the doll as "she," thus parently assuming that the primary user of dolls--or bears--is a "she."

Hartley and Goldenson (1963) examine the concept of play as a rehearsal of adult activities.

> For instance, toilet training may go more smoothly when Janey can rehearse for it by setting her doll on her own small toilet seat and telling it, "Now you go siss in the toilet and not in your panties!"

We will propose later that with the appropriate accessories and a supportive environment, doll play can become a "rehearsal" for science, math--even invention.

Another impact of doll play is sex role stereotyping. Boys are generally discouraged from playing with dolls and girls with marbles. When boys do play with them, the dolls are often males who are active, in control and powerful (e.g., G.I. Joe). There is now little disagreement with the proposition that this kind of adult-sanctioned play activity "can lead to diverting the girls toward traditional feminine occupations like teaching, home-making, etc. and boys towards law, medicine, engineering, etc. (Kaul, 1984). Appropriate doll play can help boys and girls learn a wider diversity of sex roles and can help develop greater behavior flexibility.

It is instructive to explore the "game of life" metaphor. If, indeed, life is a "game," then we learn the rules early and from play activities. Adult male language is, for example, full of athletic terms learned at play (e.g., "to touch base," "to play ball with them," and "to hit the ground running"). Male life is played as a competition. Little wonder that girls whose play has been doll play with a cooking oven, ironing board, tea set, etc. have little trouble with the challenges of household management. Men, on the other hand, "compete" for power and prizes (money) in the world outside the home. If they earn less money or "win" less power than they expected, they feel "defeated." Men seem to be more comfortable with the "power" activity of invention--an activity that brings about change.

Interestingly, in recent interviews, women inventors reported, without exception, that they identified with their fathers, who taught them risk-taking and how to use tools (boys' toys). An interesting story comes from Margaret Knight, who was granted 26 U.S. patents, including some for internal combustion engines and two for the machines that made possible the inexpensive manufacture of the square-bottomed paper bags we use today. When she died, newspapers praised Knight as the "female Edison."

> As a child . . . dolls never had any charms for me. I couldn't see the sense of coddling bits of porcelain with senseless faces; the only things I wanted were a jackknife, a gimlet and pieces of wood. . . . I was always making things for my brothers. Did they want anything in the line of playthings, they always said, "Mattie will make them for us." I was famous for my kites, and my sleds were the envy and admiration of all the boys in town (Mozans, 1974).

Barbie and the American Girl Series

A diversity of dolls have entertained and educated youngsters throughout history. We choose to focus on two currently available families of dolls. Barbie and her friends are familiar to nearly all American audiences. We also introduce the American Girls Collection to those who have not met Kirsten, Samantha, and Molly. In the next section we will suggest, by way of examples, how these dolls can help girls "rehearse" behavior that acknowledges the importance of science and math education, and encourages that special creative and powerful behavior called "inventing."

Barbie has long been accused of encouraging girls to value pretty clothes and "sex appeal" above all else. When Barbie celebrated her 30th birthday in 1989, there was a shower of hostile articles and editorials suggesting that both Barbie and Ken are, and have been, vacuous and generally poor models for the new woman and her new mate. Yet, in a limited way, Barbie's accessories have allowed her to model a broader spectrum of roles than any other doll in history.

The details are important. Barbie was an astronaut 18 years before the world heard about Sally Ride, a doctor while other dolls were still nurses. For many years Barbie Dolls have represented all races, while most other dolls were only blond and blue-eyed. Barbie's accessories take her to the office and on varied adventures. Barbie may still be very fashion conscious and many little girls like to play with the bride accessories. Nevertheless, Barbie offers choice, and under the appropriate supervision, allows for a diversity of role experimentation.

The American Girls Collection produced by the Pleasant Company is as fascinating as Barbie. Three dolls come with costumes, accessories, and eighteen story books that define the origins, lifestyles, and adventures of the three girls. Kirsten is "a pioneer girl of strength and spirit" who lives circa 1854. She is part of an immigrant family from Sweden who farms on the American frontier of Minnesota. Samantha, "a bright Victorian beauty," lives circa 1904 in a world of "old-fashioned properness, at a time when America was popping with newfangled ideas." Molly, (1944), "a lively, lovable schemer and dreamer," lives in a World War II setting (Pleasant Company, 1990).

Additional kits and manuals are designed to have mother and daughter, together, learn crafts and knowledge related to each doll's time period. For example, in the first of the Samantha books she is working on a cross-stitch project. A kit can be purchased so that the child who owns a Samantha doll can learn to cross-stitch. Additionally, a loom is available to teach weaving skills and kits for cooking, sewing, and theater teach more subjects. Building on this wonderful concept, we propose activities which teach creativity--especially as it suggests technology-related invention. Molly could have a building project that requires her to invent a solution to a problem and then build with the use of traditionally men's tools (boy's toys).

Doll accessories and costumes can teach new ideas and skills but can also limit exploration. G.I. Joe, for example, has action accessories and costumes. He can SCUBA, box, and engage in a diversity of war "games." He does not have a wedding outfit (tuxedo), a sewing machine, or school supplies. Barbie, Samantha, and Molly each have an attractive closet (with pretty hangers) to store clothes. G.I. Joe does not. Children who play with Kirsten learn that an 1854 frontier girl would store her clothes in a trunk (available for $150 plus tax).

Barbie's wide array of accessories makes it possible to imagine and rehearse a variety of behaviors. On the other hand, there are limits to her accessories which may curtail "role rehearsal." Barbie does not own a carpentry set.

In Meet Samantha (Adler, 1986), we learn a stereotype of 1904 behavioral expectations. The impressionable reader may also learn about "appropriate" behavior. Samantha has her heart set on a beautiful doll.

> "I could earn the money to buy her, Grandmary. I could make boomerangs and sell them. The Boys' Handy Book shows just how to do it. I could . . ." "Samantha!" Grandmary was shocked. "A lady does not earn money."

Interestingly, Samantha is surrounded by female servants who work for their livelihood. To underline the counterpoint, she cites an adult acquaintance: "Cornelia says a woman should be able to earn money. She says women shouldn't have to depend on men for everything."

Samantha is very creative and invents her way into and out of a great many adventures. She learns about poverty and race relations in the context of her Victorian setting. Excellent illustrations enrich the words. Surely the owner of a Samantha doll must be stimulated to think, imagine, even test new ideas. Where else could the American Girls Collection lead?

New Directions

The suggestions which follow are, at best, brainstorms to stimulate the reader to invent ideas. Perhaps toy manufacturers will accept the challenge and produce accessories to encourage girls to develop their creativity, especially as it impacts on invention. Surely one can devise doll accessories, stories, and activities which encourage girls to include math and science in their career repertoire. Surely technology can become a valued interest and activity for girls. As a parallel, men and boys, with proper play activities for them, will begin to accept girls as equal partners in the world of inventing and patenting.

Our suggestions are less important than the goals. We encourage readers and toy manufacturers to generate their own costumes, clothes, stories, and activities.

Barbie is surely a powerful influence on girls. Mattel has given her a diversity of activities, as listed earlier, which range from bride to astronaut. What is lacking is any role development beyond a superficial level. Perhaps greater depth in a single role will help her to become a more three-dimensional person and a richer source of inspiration. If Barbie is an astronaut, then perhaps she studied physics, astronomy, and similar "hard sciences." Perhaps she is a trained engineer or an accomplished scientist. In addition to her camper, perhaps Barbie needs a high-tech space vehicle. Again, accessories and stories can give Barbie a new and richer image and generate an enhanced Barbie "mythology" for the new girl/woman.

Furthermore, as Barbie skis, flies, and climbs mountains, she will learn to take personal risks--an important trait of the inventor. As she collects tool accessories, perhaps repairs her own automobile, she will develop a facility with the tools necessary to implement her ideas in the form of prototypes and working models. Barbie needs to confront more problems and solve them with thinking skills that can be learned by the children who play with her.

Not all of Barbie's problems need have the import of such issues as the environment, world hunger, and world peace. Deciding what to do on a date with Ken can teach a skill. "Morphological synthesis" is a popular technique used by those who invent ideas. The technique involves the rules of "brainstorming" as well as some problem analysis. Figure 1 shows a sample "morph" that Barbie can use in planning a date. While many of the ideas are "weird," children can learn that not all oysters have pearls, that one needs many oysters to find a few pearls. Children can learn to "tone down" and develop some of the "weird" ideas.

In Meet Molly (Tripp, 1986), one finds Molly and her friends trying to invent costumes for Halloween. Although they struggle through a process similar to "brainstorming", they are less successful than they might be (mother finally comes up with the implemented idea) because they don't understand the "deferred judgment" principle. This principle suggests that before any idea is evaluated, many ideas should be collected. Because Molly and her friends "put down" each idea as soon as it is verbalized, they discourage one another and do not use common criteria to evaluate all ideas. They would do well to learn the rules of "brainstorming" (Figure 2) and practice them on a variety of problems.

Interestingly, the girls pride themselves on their creative attitude and their efforts to develop original Halloween costumes each year. Molly's brother becomes the counterpoint. Ricky "was dressed as a pirate. Ricky was a pirate every year." Will girls read this as an endorsement of women's creativity? Is the "put down" of boys harmful?

When Ricky plays a mean trick on the girls; they invent a way to punish him. Again, their brainstorming is less effective than it might be because they criticize each idea as soon as it is stated and, in effect, "put down" the girl who put forth the idea. Here is another opportunity to learn and practice new problem-solving skills.

It is noteworthy that Ricky, too, is stereotyped. His role as pirate is active, adventurous, and somewhat wicked--traditional male behaviors. To emphasize this point of role stereotyping we retell an experience of one of the authors of this paper. As a youngster she loved to play imaginative sea-going games. She dropped anchor from the end of the dock, skippered ships from the top of her boat house, and, like Ricky, let her imagination go to sea. Our "sea captain's" mother went to a local bookstore to buy the "adventurer" some sea stories. "And what age is the boy," asked the sales woman.

Samantha, struggling with the Victorian tension between the proper behavior for a proper lady and the "newfangled" ideas about women's rights and opportunities, might enjoy meeting some of the inventors of her day. Harriet Tracy received eight patents between 1868 and 1902. Her several improvements on elevators culminated in her "safety elevator," which was selected for installation at the 1892 Columbian Exposition in Chicago.

When we first meet Samantha in 1904, Catherine Ryan had just been granted the first of six patents for self-locking nuts and bolts--an idea which revolutionized the process for joining railroad tracks (as well as streetcar tracks) to each other. She came upon the solution when, while fingering her wedding ring, she realized that it did not fall off because her knuckle acted as a "lock."

Would Samantha want to discuss creativity with Helen Blanchard, who developed the American Buttonhole, Overseaming & Sewing Machine Company based on her 24 patents--all but one, improvements on sewing machines or attachments? (The exception was a patent for a pencil sharpener.)

Samantha might be interested in the career of Archia Ross, a Black woman, who received three patents for useful inventions, including one for a new kind of closure for handbags. Samantha could hardly contain herself when Uncle Gard brought his strange, new automobile to the house. Perhaps one could arrange a meeting with Mary Anderson who, in 1903, patented an improved window cleaning device for streetcars which was adapted for automobiles to become what we now call a windshield wiper. Or perhaps it would be fascinating to the ever-curious Samantha to meet Margaret Knight, who was quoted previously as preferring a pocket-knife to a doll. Perhaps "Mattie" would have been happy to help Samantha construct the boomerangs she was anxious to sell.

Similarly, Kirsten, when helping to iron the family laundry in 1854, might well have used the new, improved sad iron patented in 1848 by Mary Cook. Or she might have wanted to meet Sarah Mather, whose invention, a submarine telescope and lamp, required a good deal of technical sophistication.

Finally, Molly, whose dad served as a physician with the U.S. Army, had a special interest in World War II. She might have been excited to meet Hedwig Kiesler who emigrated from Austria to escape the Nazis. With a colleague, she invented an antijamming device for military use. The technology continues to be used in defense satellite systems. Subsequent research in "frequency hopping" cites the Kiesler/Antheil patent as the generic work. Kiesler became the famous actress and "sex goddess" Hedy Lamarr.

Epilogue

> If proper play opportunities and material are made available to them they learn to observe, experiment and solve problems. . . . Much of what they come into contact with leads them through the process of internalization of experiences to develop concepts and

lays the foundation for later higher level thinking (Kaul, 1984).

Our goal in this paper has been to suggest that women and girls are not generally encouraged to study math and science or to be interested in technical matters. Women do not receive patents in proportion to their numbers in the general population.

Girl's play teaches woman's work. Dolls and their accessories provide role models and define woman's place in society. We propose that dolls teach girls how to participate in the "game of life." While a new array of toys may be helpful, we believe that existing dolls, when appropriately accessorized, can be important to the development of girls' creativity and role aspirations. We purposely selected dolls which are hugely popular and which, we believe, have already made great strides in helping girls grow into fully functioning human beings. Our suggestions serve to point to new directions for those who supervise girls' play as well as for the manufacturers of dolls and related toys.

There is no reason why girls--and boys--should not play with dolls. Indeed, as we have suggested in this paper, doll play may be important to development. It is important, however, that doll play not be limiting and that it provide opportunity for testing and rehearsing a wide diversity of role behaviors.

References

Adler, S. S. (1986). Meet Samantha. Madison, WI: Pleasant Co.

The American girls collection fall catalogue (1990). Madison, WI: Pleasant Co.

Darrow, W. (1970). I'm glad I'm a boy! I'm glad I'm a girl! New York: Windmill/Simon & Schuster.

Einon, D. (1985). Play with a purpose. New York: Pantheon.
Hartley, R. E. & Goldenson, R. M. (1963). The complete book of Children's Play. New York: Crowell.

Kaul, V. (1984). Play as an instrument of child growth. In Play and Child Development. New Delhi, India: National Institute of Public Cooperation and Child Development.

Mozans, H. (1974). Women in science. Cambridge, MA: MIT Press.

Sherman, P. (July, 1980). Interview.

Tripp, V. (1986). Meet Molly. Madison, WI: Pleasant Co.

U.S. Department of Commerce, Patent & Trademark Office (1990). Buttons to Biotech. Washington, DC.

FROM IRONING TO TRANSPLANTS: WOMAN AS INVENTOR

Fred M. Amram (612/378-2335)
Univ of Minnesota, Mpls., MN 55455

An case study of the history of ironing shows that woman's creativity has been reflected in her efforts to invent herself out of drudgery. Women have received patents for their contributions ranging from the mangle to the steam iron to wash-and-wear clothing. Having invented themselves out of the laundry, women now patent high-tech inventions worthy of great profit and Nobel prizes. This history of women inventing must be part of the classroom experience for all youngsters.

The Problem

Schools must do more than teach creative-thinking skills. Schools must find ways to motivate youngsters to take their inventing skills outside the classroom and to apply them in the real world of work, play, and relationships. Furthermore, schools must be sure that female students have equal access to a positive history with role models that lead to attitudes of personal power and self-confidence. Finally, boys must be exposed to a history that includes powerful and creative women so that they, as men, can provide the support and encouragement that women have so long provided men.

The next section provides a mini-history of technology, a case study of a single set of problems taken from "woman's work" to illustrate how women have responded to their social environment as agents of change. The fact that men, too, have contributed to this history of inventions is irrelevant for us. We want to illustrate how one can present a history of invention without using male examples. The teacher can create more balanced models.

Removing Wrinkles: A Case Study

> Then the eyes of both of them were opened and they realized that they were naked. So they sewed fig leaves together to make themselves loincloths (Genesis III, 7)

Stones, balls of glass, and similar fabric "smoothing" tools were found in the graves of early Scandinavian women. These primitive forerunners of irons were vigorously rubbed on fabric and surely great energy was required to achieve the desired results.

The heated smoothing iron became useful when flax, cotton, and silk could be spun into fine thread that, when woven, would respond to heat. The early Chinese used a heated "pan iron" as early as the eighth century. Burning charcoal was placed into the brass, bronze, or iron "bowl." A handle, sometimes made of bone, wood, ivory, or jade, extending from the side of the bowl was used to rub or "press" the heated pan on the fabric.

By the 15th century, some Europeans were placing hot charcoal into an enclosed "hot box." A handle over the top enhanced "pressing." To keep the charcoal burning, the "box" irons usually had a chimney, or an air circulation device much like a fireplace, to aid combustion. Holes near the bottom provided the charcoal with fresh oxygen while spaces near the top provided an exhaust (to emit "exhausted" air). Unfortunately, charcoal dust was released from the holes and chimneys, causing "smuts" on the clean fabric. Interestingly, Anna Niffeler received a U.S. design patent for a charcoal heated tailor's iron as recently as 1868. The iron, which was heated internally with charcoal, included specifications for a series of small perforations to be placed on each side of the iron. Understandably, these were sometimes omitted in manufacture.

Box irons heated with "slugs" were developed concurrently with or subsequent to the charcoal-heated iron. The history is not clear. Slugs were heated in or on a stove and placed inside the iron. While the "slug" irons eliminated the problem of charcoal dust on clean fabric, they required some additional effort. Slugs needed more frequent replacement in the box because they did not retain their heat as long as the burning charcoal.

Another solution to the problem of heating the smoothing or pressing tool was to create a solid piece of iron which could be heated externally, usually on a stove. It became the tool of choice for most, and certainly impacted the English language. Even now we refer to the object as an "iron" (although modern versions are not made of that material) and the process is called "ironing."

The work of smoothing fabric has often been referred to as "pressing" because one presses the iron on fabric to achieve the desired outcome. Interestingly, the tools have often been called "sad"-irons--not, however, a reflection of the feelings evoked by the work's drudgery. Rather, "sad," is a medieval word for "heavy," which accurately describes most of the irons. The added weight assists in the "pressing" of the cloth. Interestingly, heated smoothing irons have frequently been termed "flat-irons" although, as becomes clear later, many are not at all flat.

The solid, externally heated iron has gone through a long history of modifications. An early improvement replaced the iron handle with a wooden one. This made "handling" the iron somewhat cooler because the wood did not retain heat as easily. However, while the iron was heating on the stove, the wooden handle sometimes charred, thus weakening the handle's structure. Furthermore, women often wrapped cloth around their knuckles to protect them from rising heat while ironing. Julie Dittrich patented one solution to the problem in 1866. She proposed a leather heat deflector or shield suspended from a detachable handle. It is noteworthy that the manufacturer of the Anna Niffeler charcoal-heated tailor's iron (cited earlier) also included a heat shield between the handle and the grip.

Surely the most popular sad-iron available is the double pointed iron with detachable handle patented by Mary Florence Potts. The iron was manufactured by many companies in the United States, Canada, and Europe. It became the standard of the industry and certainly the most popular sad-iron ever made.

The body of the Potts iron was cast hollow (rather than solid) and the bottom had a thicker layer of iron than the sides. It was filled with material that was a non-conductor of heat, such as plaster of paris, cement, or clay. Consequently, not as much heat would radiate up as from earlier irons. Potts also claimed in her 1870 U.S. patent (reissued in 1880) that her iron held the heat longer so that more articles could be ironed without reheating the iron. Another advantage of this solid one-piece double- pointed sad-iron was that one could iron in either direction. A rounded handle made the tool more comfortable for the wrist.

Mary Potts' masterpiece was the detachable handle patented in 1871 (reissued in 1872 and 1879). She designed a mechanism that permitted the user to place the iron on a hot stove and remove the handle so that the handle would stay cool. Indeed, it was easy then to heat several bases at once, pick up the base which was most hot--or even one of a different size, more appropriate for the task--and continue to work with the cool handle.

Potts' inventions were licensed to many companies, and even after the patents had elapsed, the products continued to be manufactured throughout the world--well into the twentieth century. Her irons are still in use in areas of Africa and other locations where electricity is not available.

The Potts irons with their separate and replaceable handles became so popular that by 1891, special machines were invented that could produce twelve to fifteen thousand semicircular wood handles in a single day rather than the three or four hundred handles produced daily with earlier technology. Many men received patents for base and handle adaptations. For example, patents were granted for charcoal, gas, and electrically heated irons, all having Potts' detachable handle. The man receiving the charcoal iron patent even states, "The construction and operation of the detachable handle is well known as the Potts sad-iron and need not be described more fully." As late as 1920, a design patent was granted to a man for a carved design on Potts' handle (Swanson, 1988).

Thanks to research by Edna Glissman, we can paint a fuller, more human story of this important inventor. We see a 17-year-old Mary Webber married to Joseph Potts. She was 18 when she gave birth to a son and only 19 years old when she received the first of her patents. The inventor had special access to the problem because as we learn from the Saturday Herald, Ottumwa, Iowa, May 27, 1899,

> wash day with its sequel of 'ironing' was to Miss Mary, as to many other daughters of Eve, a time of tribulation. That old iron with its solid metal handle, needing always a 'holder', and then scorching the clothes and scorching the hand was a nuisance.

Young Mary also had access to a special skill that might provide a solution. Her father was a plasterer who must have taught Mary a trick or two. The Herald reports that Mary "would try an experiment . . .:

> A paste board rim was prepared and put around the top of the iron, and then the inclosure filled with plaster paris. That protected the hand from the heat. Then it seemed to her that the shape of the iron could be improved. And lastly the iron handle was disposed and replaced with a wooden, detachable handle. Such was the invention.

Specialty irons provide special insight into the interesting detours of technology and the amazing ingenuity of inventors. One learns that invention often follows the dictates of fashion.

The goffering iron may have been in use by the Greeks as early as the 4th century BC. It was certainly popular in 16th-century Europe, where it shaped the intricate ruffles and tucks that abounded at the time. An upright stand held one or more cylinders closed at one end.

> A heated poker-like iron was inserted into the open end of the barrel and when sufficiently warm, the duly starched material to be treated would be smoothed over the barrel with the fingers, one tuck at a time. Indeed a long and tedious process (Jewell, 1977).

Fluting irons and fluting "machines" are direct descendants of the goffering iron. Using heat and pressure, the principle of traditional flat-irons, these devices could make multiple pleats more efficiently. In 1866, when fluting, ruffles, and flounces (made of lace or of the same fabric as the dress) were popular trimmings on women's dresses, Henrietta Cole was granted a U.S. patent for an improvement in fluting devices which was sold both as a table model and as a smaller, more portable "pony." The patent was reissued in 1887.

On April 3, 1866, Susan R. Knox was granted a U.S. patent with William Corrister for a fluting machine. Later in 1866 another patent for fluting machine improvements was granted to Susan Knox exclusively. Both patents were reissued in 1870. The products were manufactured by several companies, including the Knox manufacturing company of New York City. Evidently the device was a huge success for a long time, because Mrs. Knox was granted a trademark for her fluter in 1877.

During the 19th century, the fashion called for starched garments, such as shirts, to display a high sheen. Polishing irons, a variation on the traditional sad-iron, were invented for that purpose. The first patent granted in the United States for any type of iron was issued to Mary Ann Cook in 1848 for a polisher. The story of her patent illustrates the workings of the product as well as her special insight from personal experience.

Cook's patent recommends her improvement as especially useful for smoothing and polishing starched shirt fronts. Apparently she had special knowledge of the problem and special insight to provide a solution:

> Common . . . sad-irons . . . have only one flat ironing or plane surface. They are not well adapted to polishing or glazing starched shirt-bosoms or other articles . . . . Experience has taught me that a very high gloss or polish can only be successfully or practically effected by a small curved convex surface, one capable of retaining a suitable polishing-heat while being used.

Her experience also showed Cook that in order to achieve greater pressure on the curved section of the iron and to provide greater wrist comfort, it was advantageous to place a downward angle on the wood handle--an early example of successful ergonomics. Apparently many were sold--and little wonder. Imagine the joy of owning an improved tool to make this onerous task a bit more tolerable.

Puffed sleeves and other rounded surfaces which required smoothing from the inside presented special problems. Certainly the bustle presented a challenge that could not be met with the ordinary box- or flat-iron. Special rounded irons were invented in the shape of balls, eggs, and mushrooms. These, too, can be considered the descendants of goffering irons. The handle often could be used as a stand while the "business end" was heated or waiting to be used. Milliners soon found uses for the rounded irons in shaping their hats.

The Tommy Iron makes for an interesting example of the rounded standing iron. Its story also illustrates how women have not always been credited with their inventions. A design patent and a trademark were issued in 1921, and a related utility patent was granted in 1922, both to Frederick E. Kern, for a shaping and ironing tool. Kern was not the inventor. Literature enclosed with later models of the tool states:

> A woman, an expert millinery designer employed by a big St. Louis firm, sat down one day and designed a new kind of electric iron for modern clothes, an iron not encumbered by a clumsy handle, so that it could slip into small sized sleeves, shirred bands, and narrow lace ruffles.

> Not only that, but she added to it a special attachment which made it into an upright iron for pressing fine laces, velvets, and delicate embroideries, another revolutionary accomplishment. As the name of this clever inventor was Miss Bertha Thompson, her friends named the new iron the Tommy Iron, and the name stuck (Swanson, 1988).

This brief history has skipped the development of self-heating irons that used coal gas (natural gas), white gas (a variant of gasoline), or alcohol. For the sake of brevity, there is no mention of electric irons except for the Tommy Iron, which did use electricity as a source of heat. To illustrate woman's involvement in the more recent history of ironing, one can add Gertrude Gross, who, in 1953, patented an early version of an electric steam iron marketed as the Handy Iron.

It is clear that women have invented solutions to their problems, often finding better ways to accomplish their tasks, and occasionally finding ways to ease the drudgery of their work. Certainly women have not always received credit for their inventtions. How many of their ideas were recorded by fathers, brothers, husbands, bosses--even patent agents? Interestingly, women sometimes receive credit where none is due. A Westinghouse advertisement, circa 1915, shows an iron with the slogan, "Women designed it! That's why the new Westinghouse electric iron is much better." While there is no evidence that women designed this par-ticular iron, from a marketing perspective, the slogan makes sense. The consumer, a woman, would believe that because ironing is woman's work, women should be best equipped to improve women's tools.

Out of the Kitchen; Into the Lab

Although, with appropriate training and opportunity, women have moved beyond the iron, it is important to note that improving irons was not trivial work. The inventions cited have made significant changes in the way women work and live. They have solved problems that women encountered in their daily lives. Nevertheless, some inventions, or series of inventions, make a spectacular difference. An example comes from the creativity of Ruth Benerito, a chemist, who, with her colleagues at the U.S. Dept. of Agriculture, worked during the 1960s and '70s to develop wash-and-wear cotton. Special treatment of the fiber affects its behavior during the drying process and helps make it wrinkle-resistant. There is little reason to own an iron any more.

Well over 100,000 U.S. patents have been granted to American women. Most of them have nothing to do with ironing or with garments or even with fabric in the most general sense. This study of ironing is merely a case study, and one would do women a disservice if one did not acknowledge the full range of their inventive accomplishments. Many case studies are possible. Perhaps it is best to end this essay with the example of a true star. Women's inventions, like those of men, range from the trivial to those worthy of Nobel Prizes. Perhaps the most important of women who have become Nobel Laureates is Gertrude Elion. It is important to note that even her most dramatic discoveries were built on the prior science of others.

Triumphing over the obstacles of gender, Gertrude Elion shared the 1988 Noble Prize in Medicine with George Hitchings, her collaborator for over 40 years. Elion's name appears on 45 patents and over 280 scientific publications, which reflect her many drug discoveries. Her breakthroughs are the result of the "enlightened empiricism" she shared with Hitchings, now called the "rational approach" to drug development, which replaced the reliance on a hit-or-miss process (Amram, 1990).

For years, pharmaceutical scientists were thwarted because virus and host cells share so many chemical processes. Drugs that can destroy one can usually destroy the other. Elion's long-standing interest in the obscure differences in nucleic acid synthesis between normal human cells, cancer cells, protozoa, bacteria, and viruses enabled her to recognize and develop a series of drugs which block nucleic acid synthesis of cancer cells and noxious organisms without damaging normal human cells --work that has had particular significance in cancer and antiviral research. Consequently, Elion brought about a "revolution in chemotherapy" when she synthesized thioguanine and 6-mercaptopurine (Purinethol), the earliest active agents against leukemia, ca. 1950, which led to the drugs that today are achieving 80% cure rates.

Elion's discovery of an improved anti-leukemic drug demonstrated that azathioprine (Imuran), which she synthesized ca. 1957, worked as an anti-cancer drug and blocked the immune response that triggers rejection of foreign tissue. That discovery was applied to successful kidney transplants. "When you meet someone who has lived for 25 years with a kidney graft," says Elion, "there's your reward."

Elion and her team worked to understand why acyclovir was so successful as an anti-herpes agent. They discovered that the compound remains inert until it meets the herpes virus, which, in a kind of suicidal maneuver, converts the compound into a substance toxic to itself. This discovery was a true breakthrough in antiviral research. "That such a thing was possible wasn't even imagined until then," says Elion. Released under the trade name Zovirax, ca. 1982, acyclovir is Burroughs Wellcome's (Elion's employer) single most profitable product.

Elion's metabolic studies contributed significantly to the successful development of allopurinol (Zyloprin) for the treatment, ca. 1963, of gout, one of mankind's most painful diseases. More recently, researchers who discovered AZT, a breakthrough treatment for AIDS, used the Elion/Hitchings protocols and worked under their guidance.

Elion is a true star. She considers her recent election to the National Academy of Science of even greater import than her Nobel Prize because it reflects peer recognition.

Epilogue

The evolution of the smoothing iron illustrates that technology is incremental. Rarely does one see a dramatic breakthrough. Inventions develop as improvements of prior inventions. As new technology becomes available, it can be applied to existing products or processes. For example, the invention of electricity preceded, and led to, the invention of the electric iron.

The concept of incremental technology is important because it tells us that an invention can be a small improvement. Most potential inventors are afraid to try because they believe that inventions require major and complex changes in technology. It is enough to improve a pencil by attaching an eraser to the end, or to affix a clip to allow the pencil to fasten onto a shirt pocket.

We began by asserting that teaching the skills of invention is relatively easy. It is difficult to motivate youngsters to become lifelong inventors--to take their skills out of the classroom and to apply them in the real worlds of work, play, and relationships. Students believe that invention is possible because, after all, it comes in small steps.

Finally, the evolution of the pressing iron illustrates that invention impacts on the way we work and play. The products of invention have a powerful and real influence on everyday behavior. Students must believe that invention is meaningful--it impacts on real lives and makes real changes in the way we live.

References

DuVall, N. (1988). Domestic Technology: A Chronology of Developments. Boston: G. K. Hall.

Jewell, B. (1977). Smoothing Irons. Turnbridge Wells, Kent: Midas Books.

McNeil, I. (ed.) (1990). An Encyclopedia of the History of Technology. London: Rutledge.

Saturday Herald (May 27, 1899). Ottumwa, Iowa.

Swanson, V. (1988). Sad-Irons Invented by Women. Unpublished paper.

U.S. Patent and Trademark Office (1990). Buttons to Biotech. Washington, DC: U.S. Department of Commerce.

The Nature of STS and STS Interactions

DEFINING STS: CAN WE REACH CONSENSUS?

Paul T. Durbin
Philosophy Department
University of Delaware
Newark, DE 19716

> What actually goes on under [the STS] label is much broader than any academic endeavor. STS is not a discipline, field, or area . . .; it is a movement.
>
> --Susan Cozzens (at 1990 NASTS meeting)

While not granting to the STS movement any theoretical core, Susan Cozzens (1990, pp. 1 and 4) does admit that STS has an ideal. This she defines as "an integrated and accessible body of knowledge to inform the STS movement," and she says it has not yet arrived. Case closed.

I agree with Cozzens in one sense. There is as yet no authoritative body of theoretical work to inform the STS movement. Perhaps there never will be. But I disagree with her in another respect. We could move rapidly toward agreement at least on a framework of discussion. And that is my topic here.

I am prepared to argue that, though competitiveness has an important place in science and technology (and can even occasionally get out of hand there), science and technology are above all collaborative enterprises. What brings this out is a focus on the process of discovery, the day-to-day life of working scientists, engineers, and other technically-trained professionals. At its best, the scientific and technological enterprise is a matter of intellectual teamwork--often undertaken out of a sense of social responsibility and for the good of humankind.

As an intellectual community, what characterizes science and technology is discourse: intellectual give-and-take, competitiveness within collaboration, the sharing not only of knowledge bases but also of motives, communication, constructive critique of one another's work--in short, dialogue. What that means is that the communities of science and technology have much in common with other intellectual communities. (There are differences, of course, but here I want to stress commonalities.) Furthermore, science and technology exist within a broader context of intellectual communities: universities, professional societies, publishing houses, the media, and so on. Even in research and development settings, scientists and engineers do not work alone but in the context of other intellectually-trained colleagues: economists, accountants, planners, and, these days at least, business-school-trained marketers and managers.

While as an intellectual community, science and technology are characterized by specific kinds of discourse, they share with all other sorts of intellectual communities an interest in those quintessential intellectual activities, discussion and argumentation. And that is what encourages me to say that we in the STS movement can find a common framework for our discussions.

DISCOURSE THEORY: THE POSTMODERNIST MOVEMENT

Walter Watson (1985, p. x) says that we live in a "semantic epoch." As he puts it:

> One hears on all sides talk of root metaphors, semantic schemata, conceptual frameworks, structuralism, paradigm shifts, language games, ontological relativity, philosophical styles, meta-philosophy, hermeneutics, and so on.

Watson's own approach to discourse theory is commonsensical and, I think, fruitful. He admits that his approach is relativist--he thinks everyone must be a relativist in some sense today--but it is a relativism that allows discussants to maintain their standards and to arrive at some definite conclusions. It is not a wishy-washy relativism.

What Watson focuses on is the four key elements of all artful discourse:

-- the writer or speaker, with his or her attitudes or perspective;
-- the object under discussion (in the extreme, an object as free as possible of subjective involvement);
-- the goal or other principle that gives discourse its meaning(s); and
-- the discourse or discussion or text proper, with its methods, means, styles, manner (and background).

These are the elements I focus on here in my search for a common ground in STS.

THE GENUS OF STS: INTERDISCIPLINARITY

When Cozzens maintains that STS has no intellectual core, she is contrasting it with recognized academic disciplines or fields. When I counter that we _can_ have a common framework of discussion, I am hoping that people from many disciplines--as well as people from professions and occupations and pursuits outside academia: teachers, corporate managers, museum personnel, environmental and other activitsts concerned with technological issues, etc.--can find meaning in a common intellectual undertaking. The name commonly associated with that sort of thing in academia is _interdisciplinary_ work. (Others prefer multidisciplinary or cross-disciplinary, but for my purposes here it is all the same.) Julie Thompson Klein, _the_ authority today on interdisciplinarity in my view, lists the STS movement as one of the prime examples today of interdisciplinarity.

About interdisciplinarity in general, Klein (1990, p. 13) has this to say: "There are interdisciplinary 'texts'. . . speeches, conference papers, institutional reports, even a number of books." The problem is that, for the most part, they are not read or discussed in common or in terms of their commonalities.

Klein says:

> Discourse on interdisciplinarity is widely diffused. The basic signals of discourse are texts, texts that are spoken, listened to, written, or read. These written or spoken forms of communication embody a further property of discourse, that of commonality: common values, beliefs, perceptions, concepts, ideas, and questions.

Though I agree that the discourse of interdisciplinarity in general is diffuse, I would maintain (and I think Klein would agree with me) that commonalities have been achieved in some interdisciplinary areas--and STS stands out among these. What is my evidence? Our NASTS conferences; the whole series of Technological Literacy Conferences.

THE SPECIFICS OF STS INTERDISCIPLINARY DISCOURSE

In this section, I emphasize particular emphases that seem to me to stand out in the discourse at our technological literary conferences--and in STS literature generally.

1. Objectivist Emphases

There are many participants in our meetings who are ardent devotees of scientific objectivity. They believe passionately in rational discourse, in weighing costs (or risks) against benefits as objectively as possible, and so on. While they might not say so explicitly, they are impatient with subjectivism, irrationality, and the like.

A good example of this, I think, can be found in a recent issue of NASTS News. There, under an editor's headline, "Neo-Luddite Manifesto Stirs Response," two of our leaders in NASTS, Irma Jarcho and John Roeder (with fellow Teachers Clearinghouse for Science and Society Education founder Nancy Van Vranken) did respond, hotly, to Chellis Glendenning's earlier contribution to NASTS News, "Notes Toward a Neo-Luddite Manifesto." With a certain scientific equanimity, Jarcho and Roeder say they could agree that much of what Glendenning said is worthy of serious consideration (Jarcho, Roeder, & Van Vranken, 1990, p. 6). But what they disagree with, vehemently, is what they see as "far-out, antitechnological diatribes." The rantings of these "anti-science and anti-technology partisans," they think, have no place under the NASTS umbrella and should not be welcomed at our technological literacy conferences. They are, they go on to say, "at cross purposes to the avowed aim of NASTS."

2. Values Emphases

But there are other voices to be heard in the halls of NASTS meetings, and an important one, with its own theme, is ethics, values, and religion. I am not sure what the partisans of scientific objectivity think about it, but Rustum Roy, from the beginning, has insisted on including under the NASTS umbrella religious and other values critics of science and technology.

In discourse terms, these are people who emphasize the importance of meaning, of purpose, of goals in any human endeavor--including intellectual endeavors and including science and technology in a special way. Scientific discourse should be as objective as possible, they admit, but it must have some noble purpose, some benefit (at least cultural) for humankind. And technological development (and the discourse that makes it possible), in its turn, must also serve noble ends, not just the demands of efficiency, of the clichéd "bottom line."

3. Creativity Emphases

A voice heard less often than the first two, but still an important one for many attendees at the technological literacy conferences, is a voice in favor of creativity, of similarities between art and science and engineering innovativeness. Gerald Holton, a hero for many NASTS members, has written several books on these themes, as well as on the imagination that is needed in all great scientific (and technological?) work (Holton 1978 and 1988).

For all her Luddism, this is what Glendenning--in response to Jarcho and Roeder and company--says she is interested in. Are they, she asks somewhat mockingly, "unable to imagine doing away with certain technologies"? Well, then, she retorts: "That is exactly the problem. A failure of imagination" (Glendenning 1990, p. 6).

4. Education and Knowledge-Dissemination Emphases

Focusing on the fourth element in Watson's analysis of discourse, many of the educators among us emphasize methods of discourse, the disciplines we have learned, the knowledge base that we need to convey to our students.

Here I would add my own concerns. I would emphasize the plurality of disciplines we represent. I would, further, emphasize the interdisciplinary experience that many of us bring to share with one another. I would also emphasize practicality: we want our students to go out and do something about technological problems--preferably something that will improve the human condition for as many people as possible all over the world. And, finally, I would emphasize, as perhaps the goal of education, that we should teach our students, in their professional lives, to favor democracy, openness, toleration of minorities wherever they possibly can. I believe many of our conferees share these views with me.

I would suggest a matrix to illustrate what I have in mind. It would include two intersecting lines with arrows at the four poles. The four arrows at the ends of the lines represent emphases on particular ones of the four basic elements in any text (in the broad sense): subject, object, aim, and method. In that sense, the matrix could be used to plot the foci of emphasis in any discourse in any community. But I would suggest concretizing the emphases here in terms of the voices heard at our STS meetings.

I would draw the basic matrix in black. The more people move toward the "pure" poles, the more disagreement there is.

I would, however, add in-turning arrows in red. The more people recognize that a given community is involved in its own mode of discourse--and thus that commonality can be found at the center of convergence--the more cross-fertilization becomes possible.

A note: At this point, some critic might wonder why I run through the four emphases one at a time, ignoring the possibility of combining them. Or why I concentrate on extreme examples. Or, finally, why I omit a temporal or historical dimension. I readily concede that there are these possibilities. Combinations, less extreme examples, a historical dimension--these are not only possibilities; they are realities, I am sure, judging from the people I have talked with over the years at our technological literacy conferences. But I do not really see any of these as objections. They would all suggest thinking about commonalities, and that is what I am trying to suggest myself.

WHAT DOES ALL OF THIS MEAN?

NASTS/Technological Literacy Conference attendees, especially teachers, have over the years complained and continue to complain about the lack of a theoretical consensus on the nature of STS--especially the lack of consensus on what they can take back to their classrooms. I have not here offered any theoretical definition of STS. What I have chosen to emphasize, instead, is the intellectual community that has developed, in only a few years, among people in STS.

All intellectual communities have their own modes of discourse, their own preferred sets of questions and answers and ways of arriving at those answers--however fleeting any consensus may be on the nature of those answers.

We are all members of intellectual communities other than (or in addition to) the STS community. Each of our communities has its standards, its revered methods, its values. These are not to be disparaged, and there is no reason, so to speak, to leave them at home when we go to STS meetings.

Many of us have the special background experiences of belonging to interdisciplinary intellectual communities. (I often say, when asked, that that is the most unique commonality among STS people.) That should give us special skills in cross-disciplinary discourse, in adapting the standards of one discipline so that they do not needlessly block communication across disciplines. (Or between teachers and professors, activists and researchers, managers and workers, etc.)

What we all have in common, if we have returned at least once to a Technological Literacy Conference, is the unique experience of STS interdisciplinarity. We have our own mode of discourse, our own favored questions and answers, even our own methods for dealing with disagreements (if we only recognize them). What I have focused on here are what I see as the nodes of a matrix defining this peculiar mode of discourse of ours. It is objectivist, normative, creative, and educative all at once--however implausible that may sound.

CONCLUSION

What I want to conclude with is the claim that we have here a unique framework for discussion, a unique forum for cross-disciplinary (hopefully trandisciplinary) discourse. More than most intellectual communities (though with many similarities to other interdisciplinary communities), we have made a unique agreement to disagree--not in just any way, but in a most fruitful way. STS, as Susan Cozzens claims, may not have a central theoretical core. But a fruitful framework within which to agree and disagree may serve us just as well.

REFERENCES

Cozzens, S., (1990). The disappearing disciplines of STS. Bulletin of Science, Technology, and Society, 10(1), 1-5.
Glendenning, C. (1990). Author replies. NASTS News, August, 6.

Holton, G. (1978). The scientific imagination. New York: Cambridge University Press.

Holton, G. (1988). Thematic origins of scientific thought. Cambridge: Harvard University Press.

Jarcho, I., Roeder, J., & Van Vranken, N. (1990). Neo-Luddite manifesto stirs response. NASTS News, August, 6.

Klein, J. (1990). Interdisciplinarity: history, theory, and practice. Detroit: Wayne State University Press.

Watson, W. (1985). The architectonics of meaning: foundations of the new pluralism. Albany: State University of New York Press.

THE SOCIAL STRUCTURE OF NATURE

John Byrne, Director, Center for Energy and Urban Policy Research, University of Delaware, Newark, DE 19716

Steven M. Hoffman, University of St. Thomas, Department of Political Science, St. Paul, MN 55105 and Center for Energy and Urban Policy Research, Newark, DE

Cecilia R. Martinez, Center of Energy and Urban Policy, University of Delaware, Newark, DE 19716

Nature is reacting to the activities of modern society in unique and largely unexpected ways. These reactions are in some ways surprising since human society has traditionally been ascribed a minor role in determining the course of natural processes. Though society has long discarded its wastes in nature, the "predominant view in the natural sciences was that life on Earth is primarily passive, responding to nonliving forces like volcanic eruptions, severe storms, droughts, and even drifting continents" (Schneider, 1989:6). While this conception of passivity is under increasing challenge, the "critical importance of human involvement seems to have been lost" in many of the recent physical and biological debates of global change (Price, 1989: 42). In those rare instances where attention is given to interactive relationships, discussion of the social and political character of human organization and activities is strangely absent. Thus, the few cases in which global warming has been portrayed in terms of nature-society interactions rely almost exclusively on units of carbon (or other chemicals) emitted per person or per unit of economic activity to characterize and measure the relationship. But the energy-environment-development nexus cannot be captured by studying the chemical content of energy-based industrial emissions alone. Indeed, the social content - the political economy - of this nexus is likely to be key to unravelling the sources and responses to global change. Perhaps the most difficult challenge is to consider whether nature is undergoing a process of social capture which eventually may make it in effect a social sub-system subject to political attitudes and ideologies, and a functioning part of the world political economy. Although the present energy- environment-development regime is only about 300 years old (dating to the spread of a coal economy, steam technology and wage labor), it has reached a level of sophistication which may render its operations a threat to several million years of climate, biological and social evolution.

SOCIAL STRUCTURE AND NATURE

Three hundred years of industrialization have rendered social and ecological relations[1] largely commodity-based. Human existence transpires within a reality of production and consumption of commodities which together release into the air and water and deposit on plants and the soil pollutants more numerous than we probably know and, certainly, more complex in their effects than we understand. This reality is structured and motivated by the logics of technology and capital; environmental consequences are, at best, a residual concern. We depend for our lives and our experience of life upon a collective capacity to produce goods and services and upon individual capacities to obtain and consume goods and services, as though nature was incidental to the human drama. As Mumford argued, society has become a "megamachine" with its members existing as so many machine parts. In the technological milieu, natural experience has all but evaporated except as an "emotional good."

There have been concerted efforts to develop social analyses which can both characterize the commodification process and challenge its hegemony over social and ecological relations. But even the most comprehensive social frameworks conceive only the possibility of social activities which degrade the environment. Structural transformation of the environment is presumed to be beyond the reach of social influence. Theories of Western political economy, for example, are regarded by many as among the most extensive in social analysis in their critical examination of social power and exploitation. But even in this comprehensive social framework, the rules or laws of nature are understood to operate literally outside the laws of social motion (as Marx termed them).

---

[1] Social relations refers here to individual and collective relations among human beings; while ecological relations refers to the interaction of humanity with all other forms of life and with the natural order as a whole.

The analytic boundary between society and nature assumed in theories of political economy does not preclude conception of relations between the two. But efforts in this direction need to observe the difference between nature-society relations and putatively social ones (especially, political and economic relations). For example, it is possible to develop a structural analysis of social activities producing pollution: social behaviors can be conceived as structurally organized to continuously disrupt or degrade "environmental quality"; and changes in social structure can be shown as necessary to remedy the pattern of polluting behavior. Such an analysis, though, leaves intact the distinction between society and nature as phenomenal structures.

Natural inquiry in its most general form likewise observes an analytic boundary between the two spheres. The influence of human beings on natural operations and vice versa, is recognized in the paradigms of biology, chemistry and physics. But again, the architectures of social and natural order are understood as maintained by relations and rules which are distinct to each sphere. In this respect, natural inquiry, like its social counterpart, operates on a premise of dual realities - one social and one natural. Implicit in the dual-realities premise, from a social point of the view, is the assumption of the permanence of nature, particularly as a reservoir for social activities. It is presumed that virtually anything can be socially practiced and repeated with the principal environmental consequences being a natural disturbance or degradation of environmental quality. To speak about environmental "spillover effects," "externalities" and "social costs," it is essential to the very logic of the language in which these ideas are conceived that one can reliably believe in the natural reservoir as, in effect, bottomless; and that the problems of environmental disruption or degradation, eventually, can be internalized within the social structure. This does not preclude social catastrophe - the starvation of large populations, the spread of epidemics, annihilation of societies or even the human species - but, ultimately, such disasters are confined to their social sphere. The permanence of nature is not obviated or negated by human disasters.

The natural point of view is similarly predicated on nature's analytic permanence. Only with this characteristic can nature provide the grounds, literally, for validation/falsification of the supposed rules and laws of natural order, the epistemological centerpiece of this mode of inquiry. We cannot think about natural order within the reigning paradigms without, at the very least, assuming a distinct order for nature. Indeed, for most practitioners of natural inquiry, a hierarchy of orders is implied between the natural and the social, with the former setting, broadly, the conditions and constraints for actions in the latter, a so-called ecology of order.

However, a range of "environmental" issues, including the rapid decomposition of stratospheric ozone and other changes in the chemical composition of the earth's atmosphere, point to the difficulties, to say the least, of maintaining the assumption of a dual reality - one natural, and one social - at the structural level. For our purposes, the most important scenario for the breakdown of the dual reality thesis is that the commodification process has functionally spread to the architecture of nature itself. In this possibility, the potential for social activity to affect its own context is thought to be great enough to redesign nature. This potential is in part an outgrowth or legacy of social behaviors under the structural guidance of industrial capital; and in part a result of the achievements of certain scientific and technological practices. Under this scenario, the forces of technology and capital are not limited to acts of natural disturbance or degradation. Rather, the very structure of nature is subjected to the design principles of these social forces. The contrast would be between capital- and technology-guided decisions to endanger the health of workers and whole communities by pollution practices at various industrial sites (which enhance profit, market position, etc.); and the collected practices of technological societies which in toto valorize a particular atmospheric chemistry (specifically, one richer in CO_2). The difference is fundamental. In the former case, a social structure- technological society - guides behaviors which adversely impact nature at the behavioral level: air, water and human tissue are poisons to some degree. But the natural order which produces air, water and living matter is not itself altered; the effect of the pollution is too small to restructure nature. In the latter, social structure threatens to cause a different natural order to evolve. This interpretation conceives commodification as having breached the nature - society duality and is now encroaching on the structural organization of nature itself. This prospect lies beyond the theoretically possible for social and physical analysis as presently organized. Apparently, however, it is not outside the reality of contemporary energy-environment-development relations.

THE PHASES OF COMMODIFICATION

In this section, an analysis of the commodification process and its evolution through three phases is offered. As developed here, the three phases represent a process of maturation in energy-environment- development relations. The reach and range of commodification embedded in these relations successively expands and manifests an accretive quality in its evolution. We do not intend in this analysis to suggest that different relations underlie each phase; quite the contrary, we believe that a common core of relations can be detected across the three periods of order and change.

Carboniferous Capitalism

In this century's most comprehensive examination of Western urban industrial growth, Lewis Mumford argued that modern society has simultaneously lost all semblance of balance with the natural order while reducing the focus of human life to the mere production of things (Mumford, 1961). An alliance of science, capitalism and carbon power reorganized social order on the pervasive principle of *quantification* (Mumford, 1961: 570):

> Quantitative production has become, for our mass-minded contemporaries, the only imperative goal: they value quantification without qualification . In physical energy, in industrial productivity, in invention, in knowledge, in population the same vacuous expansions and explosions prevail.

The new social order produced goods at an unparalleled rate and magnitude, but also pollution of a type and scale hitherto unknown (Mumford, 1934: 168-169):

> In this [industrial] world the realities were money, prices, capital, shares: the environment itself, like most of human existence, was treated as an abstraction. Air and sunlight, because of their deplorable lack of value in exchange, had no reality at all. . . the reek of coal was the very incense of the new industrialism. A clear sky in an industrial district was the sign of a strike or a lock-out or an industrial depression.

The nature and contents of what Mumford called the "atmospheric sewage" of modern industry changed in the 20th century, but the chain of energy combustion-to-environmental degradation was not altered. The alliance of science and technology, the power complex, and the industrial economy ushered in a social order of environmental mining and pollution as a functional part of human progress. In effect, pollution was "normalized."

Lasting well into the 20th century, the phase of *pollution normalcy* is distinguished by its rationalization of nature as alternately a resource mine and a bottomless sewer into which the afterthought of industrial production could be deposited. The industrial degradation of nature, of course, did not exempt human life from the damage. Indeed, industrial tolerance for pollution presupposed that human suffering was a necessary part of the equation. As the air was fouled with technological and economic advance, 20th century cities, like their 19th century counterparts, were afflicted with the worst pollution. Circulated through an industrially-manufactured cloud of chemical waste (mostly energy-based), urban air worldwide exacted the price of modern existence - life threatened by the involuntary, heretofore life-giving, act of breathing. Chronic bronchial, lung, circulatory and heart problems were and are the special mark of industrial civilization.

When the industrial elites worried at all about pollution or social health, it was to assure that popular efforts to address these problems were kept strictly local and posed no threat to profit-making. In this objective they were assisted by the "new thinking" of economics which abstracted environmental social abuse from the workings of the production regime, assigning them the residual status of an "externalities." In this treatment, those who profited from pollution or threatened human health were exempted from responsibility for cleaning up; society as a whole was to bear the burdens of progress. Policy and law followed the "analytic" view of the economists, giving institutional permission for the waters, land, air and the human body to be used as dumps.

The legitimation of pollution and disease, while a defining facet of early capitalism, must be understood within the broader context of the commodification of society. The target of capitalist development in its first century was the transformation of all social activities into commodities to be valorized in markets and exchanged for cash. Labor, leisure, sexuality, emotion and, above all, the human experience of time were stripped of their intimacy and personality, and reconstituted as anonymous units of objective economic value. The reduction of nature and the human being to a supplier of resources and a repository of wastes was an instrumental component of the commodification process; but exploitation (of humanity and nature) was the driving force of the period.

Technological Authoritarianism

A series of pollution spectaculars beginning in the late 1960s disrupted the quantitative existence of industrialism. One of the most significant for the U.S. occurred in January 1969 when an oil well off the shores of Santa Barbara, California, drilling to a depth of nearly 3,500 feet suffered a "blowout, an uncontrolled eruption" of oil (Easton 1972: 8). The eruption lasted 12 days, creating an oil slick of one to three million gallons of oil and covered an area of 800 square miles (roughly two-thirds the size of the state of Rhode Island). Fifty five miles of coastline were washed with a "black tide" of approximately 1.3 million gallons of oil. The greatest danger occurred along a seven mile stretch of Santa Barbara waterfront where 390,000 gallons of crude came ashore. The toll on wildlife was substantial: 6,000 to 15,000 birds died as a result of the blowout, as well as 74 elephant seals and five whales (Easton, 1972: 257-261). The well was eventually capped with a 3,400 foot column of cement but significant seepage from rock and sand fissures caused by the blowout continued for several years. Seepage is still occurring 21 years later.

While politically important for the U.S., the Santa Barbara "spill" ranks a mere 46th in the calvacade of modern oil spill spectaculars. A second environmental warning on March 23, 1989 suggests how greatly the scale of damage has escalated. The Exxon Valdez oil tanker ran on that date into a reef in the Alaskan Prince William Sound and spilled 37,415 tons of crude. The oil spread to five National Wildlife Refuges and three National Park areas; the slick covered 900 square miles - roughly three-fourths the size of Rhode Island. Hundreds of miles of shoreline were washed with a black tide, in some places up to 6 inched deep. The estimate of birdkills was 100,000, including 150 bald eagles. Approximately 1,000 sea otters were also killed. Debris from the oil spill was in excess of 100 million pounds; a repository for this magnitude of waste must still be found.

The Santa Barbara and Prince William Sound devastations point to an important transition in energy- environment-development relations. No longer is the fuel source, its emissions or its wastes the principal agent of environmental violation; while oil gushed from the Santa Barbara well and emptied from the Valdez, it was the technological system and its normal accidents (Perrow, 1984) that was the cause of each disaster. In this regard, society presently degrades nature not because of its commitment to a carbon economy, but because of its commitment to technological progress. We risk environmental disaster because we are a technological society.

Oil spills are only one category of pollution spectacular experienced as part of the normal operations of contemporary industrial political economy. In addition, there has been a ubiquitous tolerance for the rapid destruction of forests and lakes. Also threatened are the interior waterways of the industrialized territories into which are dumped the liquid and solid effluvia of civilization. This source is undeniably obnoxious, but dated in its sophistication. Like coal slag, the dumping of industrial wastes in streams, rivers and lakes is a product of old-fashioned technology. The manufacture of "acid rain," on the other hand, is a more modern and insidious technique for fouling waters. The important elements of acid deposition, sulfur dioxide and, to a lesser degree, nitrogen oxides, are transformed chemically in the atmosphere and fall to earth as acidic rain, snow, fog or dry particles. Damage to aquatic resources, estuaries and costal waters, timber and recreational resources, buildings, monuments and statues, and public health are the result.

The geographic scale of acidic damage being experienced and the particular chemistry of the acids involved are distinctive to our technological civilization. Only advanced political economies can manufacture this pollution order. While not a product of spectacular technological failures - continental and transcontinental acid pollution is, rather, a systemic emission of mature industrialism - this pollutant nevertheless derives from technological progress and is remediable only by sophisticated technological means. In this respect, our social and natural futures are increasingly contingent upon even more intensive social commitments to technological progress.

A third example of technological pollution is nuclear power. In this technology, societies create both the conditions for pollution spectaculars and long-term, transcontinental-scale threats to all forms of life and habitat. With the knowledge of nuclear fission, the human race acquired the permanent capacity to destroy the basis of life on earth (Schell, 1982). This capacity renders obsolete nature as we have traditionally known it. No society can escape the threat of nuclear annihilation, but must depend upon the mutual decisions of the community of nations to forego use of certain applications of atomic knowledge. A parallel condition of dependency upon social decisions/actions exists for the natural order as well.

It is not simply nuclear weapons that thrust society into the forefront. As was learned in the Chernobyl accident, civilian applications pose a sizable threat as well. While the catastrophic dimension of the accident cannot be overlooked, an even more serious question is raised in its aftermath. Traces of iodine 131 and cesium 137 in milk throughout Europe underscore the enormously hazardous risks associated with the use of nuclear reactions to produce electricity. The gases, and their components, released in the accident are the same as those to be found in a safely operating reactor. The rubble at the Chernobyl site is dangerous to human health for tens of thousands of years; but so are the interior surfaces of the containment vessels of nuclear plants retired after decades of successful, accident-free operation. Indeed, the rubble is no different in the risk it poses to life than the waste products generated from the normal operation of a nuclear plant.

In this respect, nuclear technology and the accidents that can accompany its use are catastrophe-prone. Nuclear energy requires, as an inherent condition of its use, that protective social institutions be constructed outside the mainstream of society which are dominated by technical experts and the military. Further, these institutions must last longer than any in the human record. Indeed, management of the nuclear waste stream requires 1,000 year nuclear security zones and 100,000 year surveillance mechanisms (Weinberg, 1979:94-95; Anderson et al, 1980: 30).

Only successful technological management and innovation can prevent the natural order from utter destruction. Yet, continued spread of modern technology will only increase the frequency of accidents, and the stockpile of long-lived, toxic waste, bringing into sharp focus the hegemony of commodity values over life-affirming ones. Notwithstanding the escalation of risk and destructive potential, industrial momentum requires acceptance of environmental degradation; a necessary trade-off if progress is to be sustained. Of course, society could go without oil retrieved from beneath the sea, or oblige investment in expensive anti-spill technology; it could reduce electricity consumption, or mandate expensive technology retrofits to remove the acidification threat; it could close all nuclear facilities and adopt a sustainable development path. But such choices would mean repudiating the very quantification ideology which undergirds modern ideals of progress. In addition, failure to take environmental risks would multiply problems in other sectors of the industrial system which depend upon existing operations of the power complex. Restrictions on new oil exploration, electricity consumption and nuclear technology would almost certainly upset the balance of the technological system. The only acceptable alternative in technological society for meeting energy needs is to resort to risky technology options like nuclear power. In this respect, modern society increasingly struggles with itself: it Is a captive of the environmental problems that it is uniquely capable in all of social history of creating; and likewise a captive of the technological solutions which, once employed, invariably breed new, more difficult social and environmental problems.

Technological requirements are paramount in the new order. Human existence has been broken into endless acts of commodity production and consumption which in turn depend for their accomplishment upon networks of technology. In an explicit sense, society is governed by technological institutions which create and manage the conditions of human experience. Nature is reduced in this phase to a technical problem. An authoritarianism of technique prevails in the social and, increasingly, natural spheres.

Big Science

Society is on the threshold of a third phase of commodification. In this new era, nature will no longer be exploited for its particular attributes but will be transformed and reshaped to meet the needs and interests of technological civilization. Whether this transformation is intentional is largely beside the point. Technological societies now, or in the near future will, possess the capacity to alter the very structure of nature regardless of intent. Global warming is both the threat and promise of this phase. As Nicholas Shackleton, a climatologist at Cambridge University, has suggested, "we are going outside what nature has experienced in the recent past 500,000 years" (New York Times, January 16, 1990: C1).

The principal "greenhouse" gases - CO_2, N_2O, 0_3, CH_4 and CFCs - have continuously increased as concentrations in the atmosphere since the pre-industrial period. The primary source of these gases is fossil-fuel combustion, which accounts for nearly one-half of the CO_2 increase and is an important source of higher N_2O. If we sum across social activities, nearly 60 percent of worldwide greenhouse emissions are associated with energy production and use. Greenhouse theory hypothesizes that an atmosphere composed of high concentrations of these gases will result in higher surface temperatures. Certainly, data on global mean temperatures over the past 100 years of worldwide industrialization confirm that the planet is warming. Although the precise magnitude and physical dynamics of the greenhouse effect remain the subject of much debate, a scientific consensus appears to have formed on its existence (Flavin, 1989:15-16).

Indisputably structural in character, the greenhouse effect includes not only the prospect of higher temperatures, but changes in sea level and the distribution and location of dry and wet land areas, as well as the alteration of a host of other biological and climatological processes. The implications for human and natural existence of such changes are serious enough in their own right. But perhaps even more disturbing is the prospect that social capacities exist to instigate such radical alterations of the natural order. The most vivid means of illustrating this concern is to first consider the process by which global temperature change is effected in an exclusively natural structure. Climatic history, heretofore, was determined by the confluence of three astronomical cycles which regulate the earth's orbital ellipse, axial tilt and wobble. The orbit cycle which fixes the earth's travel within the solar system takes approximately 100,000 years to complete the series of elliptical modifications involved; the tilt cycle lasts about 41,000 years to accomplish a series of axial corrections; and the elapse of the wobble cycle is nearly 23,000 years. Together, these cycles control the timing of global warming and cooling by altering the angles and distance from which solar energy reaches the earth.

To appreciate the magnitude of social interference, these very long-lived cycles must be placed alongside the 300 years of industrialization (with the last 100 years representing, by far, the most carbon-intensive), which are cumulatively believed to have begun a social process of temperature change. The time disjuncture in these terms of reference points to the immense capacity assembling in the world political economy to threaten nature. Even skeptics of the present status of the greenhouse effect should be awed by the potential for social engineering to change the natural structure, which, if not available presently, almost certainly will soon be.

The carbon buildup that has accompanied industrialization is a testament to the systematic imposition of commodity values on the society-nature relation. It is the environmental expression of energy-economic quantification. The depth to which commodified nature is presumed by the existing social order can be exemplified by considering how the carbon dependence of modern development might be slowed or reversed. In a remarkable series of scenario analyses for a U.S. Environmental Protection Agency (EPA) report[2] on *Policy Options for Stabilizing Global Climate* (Lashof and Tirpak, 1989), some indication of the carbon dependency of the world political economy is given. Using a 110-year planning horizon, the EPA study first sought to identify a series of global carbon-reduction strategies which might stabilize atmospheric greenhouse gases at a concentration which assumes a 1.5 - 2.0 C increase in global average temperature. That is, the first scenario *assumed* that global warming is inevitable, but that we can hope to place a ceiling on the magnitude of warming. Introducing policy options iteratively into the climate change model used for the project, the researchers discovered that single, or even limited numbers of, policy steps could not achieve chemical stability. Rather, *eleven* major initiatives would be needed which ranged from a phaseout of CFC use by the year 2003; a major reforestation effort worldwide; adoption of a series of energy-efficiency improvements including the achievement of a global fleet-average auto fuel efficiency of 50 miles per gallon (mpg); and government- sponsored speedup of the commercialization of solar technologies. Even with these substantial responses implemented, the study relied upon increased nuclear power production[3] to meet the goal of a warming commitment of 1.5-2.0 C.

A second simulation defined the objective as no *additional* warming beyond the year 2000. Again, policy planning was stretched over the period from the present to 2100. The analysis assumed implementation of all strategies in the atmospheric chemical stabilization scenario, and eight additional policy responses. High carbon emission fees are imposed on the production of fossil fuels in proportion to CO_2 emissions potential; and an excise tax on fossil fuel use is enacted for the industrialized countries. Separate auto fuel efficiency standards are imposed on the U.S. which require SO mpg fleet averages by 2000 and 65 mpg by 2025. And, deforestation is halted worldwide by 2000, and reforestation efforts are doubled over the stability scenario.

These analyses demonstrate the results of 300 years of commodification of society and nature. Just to moderate the process (the stability scenario) requires extraordinary global cooperation. To begin to undo the commodification of the atmosphere (the rapid reduction scenario), global cooperation is not enough - steps toward the restructuring of industrial societies is needed. Bluntly, the removal of the prospect of transforming nature depends upon radical structural action in the social sphere. Nature and society are now structurally joined.

The manufacture of acid rain and holes in the upper ozone, the extinction of plant and animal species (and the engineering of new ones), the reduction of the planet's capacity to breathe (due to deforestation, among other things), the manufacture of highly toxic, long-lived poisons which are so dangerous that they require 1000 year security zones, and the creation and satisfaction of consumptive appetites which in their aggregate portend a change in global climate - all have become rational and efficient. A recent article in the *New York Times*

---

[2] The report, published in draft in February 1989, has yet to be released in final form.

[3] Although, to rationalize the technology's promotion, it was necessary to assume annual 0.5% *decreases* in construction costs, something the world has yet to experience in 40 years of operation of the industry.

(November 19, 1989) concerning the debate over global warming and the possible need to restrict world carbon dioxide emissions is illustrative of the advanced industrial mind. In the article, Harvard economist Thomas Schelling pointed out that, "both the will and technological ability to adapt to radically different weather [has changed rapidly]. In 1860 two percent of Americans lived outside temperate or subtropical zones. By 1980 the percentage had increased to 22 percent." Schelling further argues that "the appealing idea of bequeathing the biosphere intact seems arbitrary. The quality of life in 100 years... will depend as much or more on the endowment of technology and capital as on the percentage of carbon dioxide in the air. And if money to contain carbon emissions comes out of other investments, future civilizations could be the losers." Citing a study by the U.S. Environmental Protection Agency which estimates the cost of protecting American coastal cities from a three-foot sea rise at $73 to $111 billion, the article notes that this is "a lot of money but not so much compared with the likely cost of prevention." The article concluded that an analytical consensus is emerging: "it may be cheapest to deal with the effects of global warming rather than the causes."

Thus, in the third phase of commodification we are committed to a form of world political economy in which global warming is the necessary risk of progress. Whereas the initial stages of carboniferous capitalism tested the statics of nature, namely, the absorption capacities of land, water and air, the advanced industrial order of global capital and markets challenges the dynamics of nature, in particular, the seasons, the tides, the breathing of the planet, and even the reproductive cycle of the atmosphere. While the emblems of advanced industrialism, like carboniferous capitalism, remain waste and pollution, there has been a fundamental breach of the nature-society relation. Advanced industrial life transpires not simply outside the constraints of nature, but relegates nature to commodity status, to be purchased and sold in the world political economy along with other products and services. The contemporary world political economy presumes that sustainability is a technological and economic matter. Although this presumption is typically manifested in economic terms and thus continues to be most concretely presented in discussions of trade-offs between environmental protection and material progress, its deeper implication is the demise of any idea of the inviolability of nature. There is *nothing* in advanced industrial logic beyond technological manipulation; not the climate, not the atmosphere, not species diversity. Nature is stripped altogether of autonomous status. Society as the master of nature fulfills the Western dream of science. Reason can replace randomness in the governance of life and empower humanity to author its future without constraint. Global warming signals the arrogation by society of the master role; science replaces nature as the basis of life.

CONCLUSION

The scientific revolution and the rise of capitalism initiated the reconceptualization of the relation between society and nature. A new mechanical world view emerged which emphasized rationality, order and power as the underlying principles of human and natural development. This world view demystified the physical and biological worlds so that nature is now "construed as ordered systems of mechanical parts subject to predictability through deductive reasoning" (Merchant, 1980: 214). Scientific knowledge about the environment has been achieved through the conceptual "death of nature" and the use of analytic methods predicated on the deconstruction of nature into its constituent parts (Merchant, 1980). In this view, nature is made up of "modular components or discreet parts... the parts of matter, like the parts of machines being dead, passive,and inert" (Merchant, 1980: 229). The emergence of the machine view led directly to the legitimation of the commodification process and the repudiation of earlier organic visions of the unity of social and physical reality. In contrast to the normative structures of organicism which regarded the exploitation of nature as a violation of life, the machine order treats nature and its exploitation as objective reality; there can be no normative content in nature when "matter is made up of atoms, colors occur by the reflection of light waves of differing lengths, bodies obey the law of inertia, and the sun is the center of the solar system" (Merchant, 1980: 193).

Because technological civilization operates without normative constraint, the only limits on society's interaction with nature are instrumental: economy, efficiency and scientific validity identify the boundaries of action. It is in this context that recent proposals by members of the policy and scientific communities to address global change need to be understood. Initiatives ranging from the imposition of a global carbon tax and emissions trading systems, to worldwide programs of reforestation, recycling, energy efficiency, the development of renewable energy options and the establishment of technology transfer between rich and poor nations offer practical means to retard or halt industrial destruction of the environment. The urgency for action which gave rise to these proposals is not disputed, but such steps leave unexamined the underlying social relations of energy, environment and development that have produced and will continue to reproduce structural threats to nature. As the principal sources of global environmental and technological threat, the existing world political economy and its corresponding development regime of commodified nature cannot be assumed as the structural context for designing rational, efficient or feasible solutions. Burden sharing, emissions trading and abatement-adaptation tradeoff schemes (Schelling, 1990) address only the effects of 300 years of commodification. They leave intact the exploitive regime and reinforce the momentum of technological authoritarianism. Moreover, these schemes can all too easily become forms of industrial escape from problems caused by the prevailing regime, thereby destining the poor to remain poor and nature under threat. Unless the causes and conditions of global inequality are removed, moreover, the poor will be forced to adopt development choices which largely imitate the energy-intensive economies of the industrialized group. After all, the borrowed capital, transferred technology and traded commodity which dominate transactions between rich and poor will continue to be the product of energy-intensive, environmentally destructive economies. But the spiral of commodified nature deepens with each addition of imitators. This is why, as Durning has observed, the environmental crisis and the crisis of unequal development must be solved together. They are, structurally, the same problem (Durning, 1989).

Human existence outside earth's atmosphere is technologically plausible and, under present institutional circumstances, perhaps economically rational. This technological fact hardly justifies the destruction of the basis of life on earth as we have known it.

REFERENCES

Anderson, Jane at al. 1980. "Decommissioning Commercial Nuclear Power Plants." Minneapolis, MN: Center for Urban and Regional Affairs, University of Minnesota.

Byrne, John and Steven M. Hoffman. 1988. "Nuclear Power and Technological Authoritarianism." Bulletin of Science, Technology and Society 7: 658-671.

Durning, Alan B. 1989. Poverty and the Environment: Reversing the Downward Spiral. Worldwatch Paper 92.

Easton, Robert. 1972. Black Tide: The Santa Barbara Oil Spill and its Consequences. New York: Delacorte Press.

Flavin, Christopher. 1989. Slowing Global Warming: A Worldwide Strategy. Worldwatch Paper 91.

French, Hilary F. 1990. Clearing the Air: A Global Agenda, Worldwatch Paper 94.

Lashof, Daniel A. and Dennis A. Tirpak (eds.). 1989. *Policy Options for Stabilizing Global Climate: Draft Report to Congress.* U.S. Environmental Protection Agency.

MacKenzie, James J. 1989. *Breathing Easier: Taking Action on Climate Change, Air Pollution, and Energy Insecurity.* World Resources Institute.

Merchant, Carolyn. 1980. The Death of Nature: Women, Ecology and the Scientific Revolution New York, NY: Harper and Row.

Mumford, Lewis. 1934. Technics and Civilization. New York: Harcourt Brace.

Mumford, Lewis. 1961. The City in History: Its Origins, Its Transformations, and Its Prospects. New York: Harcourt Brace Jovanovich.

Perrow, Charles. 1984. Normal Accidents: Living With High Risk Technologies. New York, NY: Basic Books.

Price, Martin F. 1989. "Global Change: Defining the Ill-Defined." Environment (October): 18-43.

Schell, Jonathan. 1982. The Fate of the Earth. NY: Knopf.

Schneider, Stephen H. 1990. "Debating Gaia." Environment (May): 5-32.

Weinberg, Alvin M. 1979. "Salvaging the Atomic Age." Wilson Quarterly (Summer): 88-112.

FROM FUSION FRENZY TO FRAUD:
REFLECTIONS ON SCIENCE AND ITS CULTURAL NORMS

R. Eugene Mellican
Department of Philosophy
University of Lowell
Lowell, MA 01854
508-934-2527

Introduction

With their March 23, 1989 press conference announcing that they had attained nuclear fusion at room temperature, B. Stanley Pons and Martin Fleischmann ignited the biggest media hype in science since the artificial heart and set off a level of frenzied scientific activity that constituted what Time magazine called "one of the strangest months in the history of science." (Lemonick, 1989, p. 73) While one prominent scientist, whose research team had replicated Pons and Fleischmann's findings, proclaimed, "It's like being there when fire was discovered," (Carey, Marbach, Maremont, & Symonds, 1989, p. 106) another publicly sneered, "The Utah team is suffering from incompetence and perhaps delusion." (Begley, 1989, p. 65) In the glare of the fusion controversy being played out in full public view, science presented itself as something other--or at least more--than simply a methodical, objective, dispassionate search for truth as one would expect in terms of its traditional ethos.

Outside the fusion spotlight, lurking in the shadows of public attention, there have recently been enough well-publicized instances of scientific fraud and other forms of misconduct in scientific research for the problem to become the subject of several congressional hearings and professional conferences.

This paper examines the transformations within the culture of science these events represent, from science-by-press-conference to scientist-entrepreneurs selling not proven products but merely possibilities of research; the extent to which the traditional standards and bounds of scientific research no longer seem adequate;

and the social and economic forces giving rise to these changes. In addressing these topics, I give particular attention to the kind of response the scientific community itself has given to these issues. In analyzing the statements and actions of leading scientists, scientific institutions, and their spokespersons, my objective is twofold: (1) to determine the adequacy of this response, both in terms of the issues themselves and in relationship to the very norms and practices that are explicitly and implicitly appealed to as validating the response; and (2) to point out the implications this response has for the public perception and control of science. In order to give sharper focus to my analysis, I am primarily concerned with science as it is practiced within academic research institutions, since it has been generally assumed that "it is the academic community which internalizes the norms of science most strongly and plays the key role in maintaining them through the institution of science as a whole." (Barnes and Dolby, 1970, p. 6)

Cultural Norms of Science

In examining science as a social institution nearly fifty years ago, the American sociologist Robert Merton defined the ethos of science as:

> an emotionally toned complex of rules, prescriptions, mores, beliefs, values, and presuppositions which are held to be binding upon the scientist....This ethos, as social codes generally, is sustained by the sentiments of those to whom it applies. Transgression is curbed by internalized prohibitions and by disapproving emotional reactions which are mobilized by the supporters of the ethos. Once given an effective ethos of this type, resentment, scorn, and other attitudes of antipathy operate almost automatically to stabilize the existing structure. (Merton, 1973, p. 258.)

Merton further detailed the ethos of modern science by identifying four institutional imperatives as comprising it: universalism, communality, disinterestedness and organized skepticism.

(1) Universalism is the demand for objectivity in considering the validity of knowledge-claims. The acceptance or rejection of claims must be totally independent of the personal, social, political, or national characteristics of their presenter. (Merton, 1973, p. 270)

(2) Communality refers to the common ownership and sharing of ideas, demanding a free, full, and open communication of findings. Secrecy or the selective presentation of findings is the antithesis of this norm.[1] The particular importance of this norm is indicated by the fact that "the institutional conception of science as part of the public domain is linked with the imperative for communication of findings." (Merton,1973, p. 274)

(3) Disinterestedness is the imperative that scientists are required to do science in ways that give priority to the pursuit of truth.[2]

(4) Organized skepticism, which Merton stresses is "both a methodological and an institutional mandate," (Merton, 1973, p. 277) requires that scientists exercise a thorough-going skepticism in assessing their own work as well as that of others. Until a scientific claim is validated by the careful application of empirical and logical criteria, judgment must be suspended and the findings approached with an attitude of professional skepticism. As Robert Oppenheimer has stated, "For scientists it is not only honorable to doubt, it is mandatory to do that when there appears to be evidence in support of that doubt." (Oppenheimer, 1955, p. 115) In regard to this norm, Merton makes an observation that has significant implications for the objective of this paper.

> Most institutions demand unqualified faith; but the institution of science makes skepticism a virtue. Every institution involves, in this sense, a sacred area that is resistant to profane examination in terms of scientific observation and logic. The institution of science itself involves emotional adherence to certain values. But...the scientific investigator does not... preserve the cleavage between the sacred and the profane, between that which requires uncritical respect and that which can be objectively analyzed. (Merton, 1973, p. 265.)

This scrutinizing, skeptical posture is frequently cited as a defining feature of science and the ultimate foundation or justification for scientific autonomy and self-governance. C. P. Snow reflects this position when he states, "There is no need for an extrinsic scientific criticism, because criticism is inherent in the process itself." (Broad and Wade,1982, p. 61)[3]

The norm of organized skepticism, then, provides a clear standard against which to measure the adequacy of both the scientific community's own critical examination of its actual practices in the face of changing economic and institutional arrangements and its response to actual cases or charges of misconduct.

Merton's formulation of the ethos of science and the extent to which its norms have ever been operative in the actual practice of science has been the subject of extensive discussion and debate. However, even those who sharply question whether the normative structure of science as described by Merton is, or ever was, actually functional in science admit that "scientists have acquired a social stereotype which resembles in broad outline the original analysis of the normative structure of science." (Mulkay, 1976, p. 647) And just as Merton extracted the norms of science from what scientists since the seventeenth century have written about their own work and the nature of science, so do scientists today appeal to the same general principles in describing the distinctive features of science.[4]

The power of this conventional view of science can be seen in the success scientists and scientific institutions have had in maintaining professional autonomy outside the purview of public scrutiny and accountability and the usual pattern of checks and balances of a democratic society despite receiving massive government funding for their work. The public should support, but not regulate science. (Greenberg, 1969, p. 28) Not only is scientific knowledge intrinsically valuable, but it can be achieved only under the rubric of the values inherent in its own ethos. Any outside surveillance would smother or undermine the very values that make scientific knowledge possible.

Social Control in Science

The practice of science, then, is generally assumed to be a self-policing activity. For science is so constituted as a social institution, it has built into it a system of social control that not only is a powerful deterrent against the violation of its norms, but also has specific mechanisms to detect any misconduct should it occur. As the Institute of Medicine said in its recent report, The Responsible Conduct of Research in the Health Sciences, "The effectiveness of self-regulation depends upon those practices and procedures that have evolved over time as part of the scientific method. Such practices are intrinsic to the conduct of science...." (Institute of Medicine [IOM], 1989, p. 18) And even when, within the same report, serious, fundamental questions are raised "about the adequacy and effectiveness of the current self-regulatory system," the position is maintained that "a variety of informal and formal practices and procedures exist in the academic research environment to assure and maintain the high integrity of research conduct." (IOM, 1989, pp. 1 and 2)

In accord with the criterion of the verifiability of scientific claims, the two most explicit and most thoroughly analyzed and critiqued means of control in science are the formal peer review system and the process of replication. Since the peer review process provides independent scrutity at every phase of the research process, from its initial funding to the publication of its results, it is viewed as the guardian of honest, careful, and quality work, if not truth. Even if one were to acknowledge the inherent limitations of this process in uncovering misconduct, since referees generally take on trust the data that is presented to them, there is still the process of replication, the independent verification of experimental results. While critics may argue it is seldom carried out, adherents of the traditional norms of science argue that just the anticipation of replication serves as a powerful mechanism for care and honesty in research. As Daniel Koshland, the editor of Science has stated:

> What is going to happen in a very exciting field, like cancer, like AIDS, and so forth, is that if you put out a false result it's going to get caught within six months to a year almost surely by someone else doing the experiment. So what's the incentive for a very prominent scientist to deliberately put an incorrect result in the literature. It's got to be silly. (Nova, 1988, p. 9)

This response, however, raises several obvious questions: How much of the scientific work published in the forty thousand scientific journals in circulation today is at the cutting edge of "a very exciting field"? By "a very prominent scientist"? How much is in fact replicated and how is replication going to determine that an incorrect result is "deliberate" and not simply due to error or self-deception fostered by clinical urgency or "the truth as he knows it to be." (Nova, 1988, p. 7) Even if one were to agree with the general thrust of Mr. Koshland's response, since it refers to fields that involve human subjects, given the time lapse and possible consequences between deed and discovery, its dismissive tone is less than adequate for even the rarest of occurrences.

The recent case involving the experimental use of hyperthermia in treating AIDS patients illustrates the inherent limitations, and danger, of the kind of position Koshland represents. The New York Times reported on September 5, 1990 that "after six months of speculation and controversy over experiments to treat AIDS by heating patients' blood, a Federal panel said today that they did not work and should not be tried again on humans for now." This experimental procedure, costing up to $100,000, was publicized as a possible cure "before any scientific papers were written or the experiments were reviewed by other physicians." In addition to the substantial risk to those undergoing the treatment, one medical director accurately pointed out, "This kind of thing raises false hope among thousands of patients." (Hilts, 1990, p. A14)

Despite the imperative of organized skepticism that leaves the practice of science itself open to critical analysis, there have been few analytic and empirical investigations into the frequency and extent of misconduct in science. In the first congressional hearing on scientific misconduct in 1981, two basic questions were asked: How common is misconduct? Does more need to be done to prevent it? The scientific community's answers at that time were: "We don't know" and "No!" The answers remain substantially unchanged today. When Drummond Rennie, an editor of the Journal of the American Medical Association, testified before a congressional hearing in 1989, Nature reported that "unlike many scientists, Rennie acknowledges that congressmen have a right to be 'surprised and upset' when the scientific community can produce no clear answer to the first question." (Anderson, 1989, p. 3)

The standard position taken over the past ten years was expressed in a New England Journal of Medicine editorial: "Misconduct is inevitable in all fields of endeavor. There may be less of it in scientific research than in other fields." (Angell and Relman, 1988, p. 1462) Jerome Jacobstein, who in 1981 uncovered a case of scientific misconduct while at Cornell University Medical School and is the current director of Nuclear Medicine at the Graduate Hospital in Philadelphia, called this position "simplistic and dangerous" and pointed out how far out of line this position is with a scientific attitude:

> The fact is that we don't know. As the editorial points out, we have no idea how many instances of fraud go unsuspected. We also have no idea how many are suspected but not pursued, how many are known but not reported, or how many are reported but covered up. Nor do we know how frequent fraud is in other disciplines. (Jacobstein, 1989, p. 57)

When confronted with actual cases of scientific misconduct, the public response of most leading spokespersons for the scientific community have been defensive reiterations of the "bad apple" syndrome. Any form of fradulent behavior is an aberration. As in any human enterprise there will always be a few individuals who will try to take advantage of the system. A classic, but not atypical expression of this view remains that of Philip Handler, then president of the National Academy of Science, when he testified in 1981 before a congressional committee on "the falsification of research data":

> In my view, that problem has been grossly exaggerated....The matter of falsification of data, I contend, need not be a matter of general societal concern. It is, rather, a relatively small matter which...occurs in a system that operates in a highly effective democratic, self-correcting mode....One can only judge the rare acts that have come to light as psychopathic behavior originating in minds that made very bad judgments--ethics aside--minds which in at least this one regard may be considered deranged....In the hot cauldron of the operation of peer review in the scientific world, such data cannot long survive undetected. And it is the culprit, not society, that is injured on the rare occasion in which this occurs. (U. S. Congress, House, 1981, p. 12)

Consistent with this position, is the generally held view that any attempt to police the system from without "would create such an atmosphere of suspicion and distrust that the free spirit of scientific inquiry would be crushed." (Relman, 1983, p. 1416) One of the most interesting arguments in the Institute of Medicine report on The Responsible Conduct of Research in the Health Sciences was given in support of the report's recommendation that the "NIH should not implement random data audits as a mechanism for ensuring the responsible conduct of investigator-initiated research." In addition to the common argument that such an intrusion would be apt to "diminish spontaneity and creativity in research," and lead to "defensive recordkeeping," the report states:

> Furthermore, the introduction of data audits will not identify all dishonest researchers. As the program became known, unscrupulous investigators in some fields might become adept at fabricating their raw data as well as their reported results. Thus, there might still be fraud, but it would be occurring earlier in the process of reporting. (IOM, 1989, pp. 27 and 28)

The rejection of scientific misconduct as a serious issue in the form of the hard-nosed, defensive posturing of leading scientific spokespersons is puzzling, if not in terms of the harm that can result to specific individuals and the public at large, then certainly in terms of the scientific ethos and the negative consequences the various forms of misconduct--from forgery, data manipulation, data suppression, and plagiarism to disreputable error or scientific negligence--have on science itself. In the face of such obvious consequences as undermining the reliability of published results and the public credibility of science; eroding the trust held to be so crucial to the research process; and diverting the research, resources, and energies of other scientists, Patricia Woolf has written that it is impossible to take at face value such official statements as that "issued from the Massachusetts General Hospital --that falsified data published by an investigator on their staff in the Journal of the National Cancer Institute had *caused no harm* 'even in the field of science.'" (Woolf, 1981, p. 13)

Given both the principle of organized skepticism and commitment to seeking truth that are so fundamental to science, surely the treatment of whistleblowers in scientific misconduct cases is not an unfair litmus test for measuring the vitality and strength of the traditional scientific ethos and its effectiveness in providing a system of social control in science. Unfortunately, in light of the evidence provided from already resolved cases of fraud, it would appear that whistleblowing in science is as hazardous an occupation as it is in the business world. As one whistleblower stated on public television's Nova program, Do Scientists Cheat?:

> The point that you can't lose sight of is that I had gone from whistleblower to a co-conspirator in the very research I had questioned. I would never go through this again. From what I've experienced, it is better to run than fight. It's just a no win situation; at least if you keep quiet it might really go away, and you can slip away and keep doing your science, and pretend it never happened. (Nova, 1988, p. 22)

A 1981 study of whistleblowers in cases of clinical research fraud concluded that "the almost universal experience of whistleblowers...is that their actions generate a vehement, angry, and often punitive response by colleagues and superordinates." (Swazey and Scher, 1981, p. 187) The most recent series of congressional hearings on scientific misconduct reaffirms this conclusion. (U. S. Congress, House, 1990, p. 63) Drummond Rennie, an editor of the Journal of the American Medical Association, has expressed the strongest indictment of the scientific community's reaction to whistleblowers:

> ...the emotional reaction to defending the herd against somebody who is perceived as attacking them, namely the whistle-blowers, seems to be at a deeper, more permanent, less thinking and more automatic level than any emotional reaction to, or any emotional commitment to truth, honesty in science. (Nova, 1988, p. 24)

Consistent with that level of professional protectionism is the evidence presented by the cases of misconduct addressed in the latest round of congressional hearings. The report shows that, in sharp contrast to the plight of many whistleblowers, most of those involved in, or charged with, wrongdoing not only do not suffer a loss of reputation or are banished from the scientific community, but "have fared well." (U. S. Congress, House, 1990, p. 62).

One of the most serious challenges to the traditional ethos of science and its capacity to function effectively as an internal self - regulating system within academic research institutions has been the rapid and growing commercialization of research, resulting in a variety of partnerships and relationships with private industry and entrepreneurial ventures. It is generally acknowledged that "in some fields the intrusion of commerce is clearly changing the character of collegial relationships and certainly the climate of competition in which research is carried out." (Nelkin, 1989, p. 306) But the main area of concern has been with the increased possibilities for conflicts of interest and the intense pressures these exert for compromising the objectivity and integrity of research procedures and conclusions.

A striking recent event that highlights the range and complexity of problems confronting science as a result of changing financial and institutional arrangements is the cold fusion controversy. This case also indicates startling gaps between the professed norms of science and its practice.

Fusion Frenzy

For any interested observer of science, the cold fusion controversy was quite a fascinating scene. In terms of the public's response, the claim to have achieved the holy grail of fusion research--a device that produces more energy than it uses--was "hysteria waiting to happen," as one science writer put it, in as much as the claim touched a deep chord in a world eager to find a cheap, safe, clean source of energy.

The response of the scientific community is a bit more puzzling, because the intensity of the scientific furor seemed at times to be generating more heat than the initial fusion claim. The manner in which scientists were hurriedly, and publicly, making claims and counterclaims around the world certainly was not science as usual and as such, the process was as interesting, and maybe more revealing, than the science itself. (Pool, 1989, p. 420)

Many scientists were angered by what they implied was a new phenomenon, "science-by-press-conference," with Pons and Fleischmann making what appeared to be extravagant claims that had not been supported with carefully recorded data, graphs, or a detailed presentation of their experimental procedure. There are two things that are surprising about this angry response of scientists. First, science-by-press- conference has been going on for at least twenty years without so much as a whimper from the scientific community. (Rothman, 1972, p. 106) Second, while this professional outrage was refreshing, over the next six weeks many of these same scientists then engaged in science-by-press-conference themselves. In fact, one scientist, frustrated at the number of researchers who were rushing to the press without even bothering to run a proper check on their results, accurately summed up the situation by complaining, "These people are engaging their mouths before they engage their brains." (Peat, 1989, p. 104)

One of the sharpest attacks on both the scientific claims of Pons and Fleischmann and their press conference method of announcements was made by Prof. Ronald Parker, director of M.I.T.'s Plasma Fusion Center. He was quoted by the press as saying, "Everything I've been able to track down has been bogus, and I think we owe it to the community of scientists to begin to smoke these guys out." (Tate, 1989, p. 4) He also attacked as "scientific schlock" the way researchers from many labs had rushed to publicize findings for and against cold fusion before publishing them in scientific journals. (Saltus, 1989, p. 12) At the press briefing before he was scheduled to present his own scientific findings to his peers where he made these statements, he failed to include himself!

What is the explanation for this worldwide breakdown in scientific procedures and protocol? One plausible explanation given is that this was simply a specific instance of what Irving Langmuir, who won the Nobel Prize in Chemistry in 1932, called "pathological science" or "the science of things that aren't so." (Langmuir, 1985) As Nathan Lewis, a chemist at Cal Tech said, "One of the main things we've learned during the course of these experiments is how easy it is to fool yourself into thinking there is an effect when actually there is none." (Pool and Heppenheimer, 1989, p. 647)

Or was it simply the case that when the stakes are high enough, the pressures and temptations are too much even for the rigorous, cool, orderly process of science? When Pons and Fleischmann appeared before a congressional committee as part of a University of Utah group requesting federal funding for cold fusion research, Prof. Ronald Ballinger, who heads M.I.T.'s twin departments of Materials Science and Engineering and Nuclear Engineering, commented, "This isn't about science, it is is about money." (Tate, 1989, p. 4)

It seems to me, though, that the cold fusion controversy is about both science and money and should be viewed as part of a pattern of the increasing commercialization of scientific research. Therefore, the cold fusion episode represents an exaggerated illustration of the kind of transformation that has been taking place at an accelerated pace within the scientific ethos for the last ten to fifteen years. It exemplifies the replacement of contextual values--in this case, commercial values--for the traditional constitutive values of science. (Longino, 1983)

There have been many instances of the announcement of scientific findings through press conferences before first presenting them in professional journals or in papers read at scientific conferences, especially in the area of biomedical research. One of the first, most notable examples occurred in January 1980 when the microbiological firm, Biogen, announced in a press conference, featuring its director and one of its researchers, that it had made a major advance in the genetically engineered production of human interferon. The potential of interferon was highly overestimated, but the announcement increased the value of Biogen's stock. According to the Boston Globe at the time, the value of the stock of Schering-Plough which owned 16% of Biogen and rights to its interferon process, increased by $425 million. Robert Teitelman, in his recent book, Gene Dreams: Wall Street, Academia and the Rise of Biotechnology, points out that "perhaps never before had more money been raised for a single, untested pharmaceutical." (Teitelman, 1989, p. 34)

Scientific announcement by press release or conference may be a mode justifiable within the operating procedures of the business world, but it is not a mode warranted in the scientific ethos of truth-seeking. The press conference format may protect claims long enough to realize some short-term commercial goals or to establish patent priorites, but it subverts many of the guarantors of the validity of knowledge claims provided by the traditional norms and practices of science. As Teitelman commented on the interferon event, "It also left in its wake the lesson that image meant more than substance, that means could be compromised to achieve desirable ends, and that a certain scrupulousness could be abandoned for expedience." (Teitelman,1989, p. 35)

Of all the forces that have coalesced to bring about the increased competitive commercialization of research, such as the development of "big science" and its resultant dependence on outside funding, as well as the breakdown in the strict division between basic and applied research in molecular biology, certainly for academic institutions the main impetus was provided by the passage of the Patent and Trademark Amendment Act in 1980 that allowed universities and non-profit research institutions to apply for patents on federally funded research, the profits to be used to support further research.

Therefore, in view of the economic stakes involved in fusion research, whether hot or cold, and the kind of serious leaks that occurred in normal scientific channels during the highly charged and publized race for the superconductor just three years earlier, is it too surprising that patent lawyers seemed to be in charge of the cold fusion research at the University of Utah, especially when Pons and Fleischmann discovered that Steven Jones, at Brigham Young University no less, was engaged in similar research? As Pons has said in his defense, "In all my scientific life, I have never seen a situation where a proposal was sent to a certain person, who calls up and says, 'Tell me more,' and who then immediately reveals himself as a reviewer and suggests collaboration. I had no idea when he was going to go public." (Peat, 1989, p. 74)

For a process so based on trust--with repeated assurances that violations of this trust are rare, non-consequential occurrences--much of the scientific behavior surrounding the cold fusion flap seemed to border on outright paranoia. Yet, in a totally unrelated context, Prof. William Nunn Lipscomb Jr., who won the Nobel Prize in Chemistry in 1976, has recently stated that the research climate has so changed,

> it has reached the point that I no longer put my most original ideas in my research proposals, which are read by many referees and officials. I hold back anything that another investigator might hop on and carry out. When I was starting out, people respected each other's research more than they do today, and there was less stealing of ideas. (Browne, 1989, p. C14)

Conclusion

Even those who have argued that the social image conveyed by the traditional ethos of science is nothing more than the "story book image of science," or that the scientific ethos functions not as a normative structure, but as an occupational ideology serving the vested interests of scientists acknowledge the social reality and power of this image or ideology. Therefore, they point to the need for "detailed, historical studies of the kinds of accounts of science offered by scientists to various lay audiences and in varying social contexts." (Mulkay, 1976, p. 647) This paper represents the beginning of such an effort in regard to recent cases of misconduct and the increasing commercialization of scientific research.

What is ultimately at stake in raising questions about the adequacy and internal consistency of the scientific community's response to the issues involved in these events is not just the public credibility of science, its continuing social power, and professional autonomy. It is, rather, the health and well-being of human beings. The three-year investigation by the Human Resources and Intergovernmental Relations Subcommittee of the House Government Operations Committee clearly captures this in the title of its just released report: Are Scientific Misconduct and Conflicts of Interest Hazardous to Our Health? Until the scientific community takes this question as seriously as they do their own professional prerogatives, the answer will remain as obvious as the question. As one scientific whistleblower has stated, those scientists are surely correct when they maintain

> that federal oversight cannot 'ensure fraud-free science.' Nothing can. But there is much that we ourselves can do to minimize fraud and thereby preempt congressional action. The main stumbling block is still, as it has been right along, the insistent refusal of the scientific community to recognize the importance of the problem. (Jacobstein, 1989, p. 57)

Whatever conclusion one is able to draw about the present state of science from such recent events as highly publicized cases of scientific misconduct and the cold fusion episode, it seems that they at least point to the need to renegotiate the relations between science and the public that were established at a time when both science and its social context were very different. (Nelkin, 1982, p. 708) It remains an open question whether research institutions and the public are up to the challenge of this complex and difficult task.

Footnotes

[1] This norm points to a fundamental distinction between the scientific process of seeking truth in which scientists are obliged to report all the relevant data, not only the supporting evidence, but also the counter evidence or uncertainties surroundng their hypotheses and an adversary process, such as in the law courts, in which contending parties present only part of the truth, i.e., that evidence supporting their position. (Wilmotte, 1970, p. 46)

[2] Since quite divergent interpretations have been given to this norm, adherents to Merton's position stress that disinterestedness is not incompatible with the personal interests of scientists. They argue that to the extent the normative structure of science and its "reward system operates effectively, that is, to the extent that it allocates credit in rough accord with the extent of scientists' contributions to knowledge, the advancement of individual careers and scientific development are wholly compatible." (Zuckerman, 1984, p. 10) For different interpretations, see Schmaus (1983) as well as Barnes and Dolby (1970).

[3] But Patricia Woolf, while affirming the indispensable role skepticism plays in science, points to the inherent tension between it and the equally essential collegial attitude: "The friendship and trust that sustain collegiality can make objective criticism extremely difficult and undermine the ability to maintain the healthy skepticism needed for evaluating the ideas, data, and conclusions of scientific research." (Woolf, 1987, p. 3424)

[4] See, for example, the recently published booklet, On Being a Scientist, written by the National Academy of Sciences' Committee on the Conduct of Science. Note especially pp. 10-19, which describes the "social mechanisms in science."

References

Anderson, A. (1989). Scientific misconduct still an unknown. *Nature*, *340*, 3

Angell, M., & Relman, A. S. (1988). Fraud in biomedical research: A time for congressional restraint. *New England Journal of Medicine*. *318*, 1462-1463.

Barnes, S. B., & Dolby, R. G. A. (1970). The scientific ethic: A deviant viewpoint. *European Journal of Sociology*. *11*(1), 3-25.
Begley, S. (1989, May 15). Fusion fever cools down. *Newsweek*, p. 65.

Broad, W., & Wade, N. (1982). *Betrayers of the truth*. New York: Simon and Schuster.

Browne, M. W. (1989, October 17). Nobel fever: The price of rivalry. *The New York Times*, pp. Cl, C14.

Carey, J., Marbach, J. D., Maremont, M., & Symonds, W. (1989, May 8). Fusion in a bottle: Miracle or mistake? *Business Week*, pp. 100-110.

Greenberg, D. S. (1969). *The politics of American science*. London: Penguin.

Hilts, P. J. (1990, September 5). Heating blood is called useless in treating AIDS. *The New York Times*, p. A14.

Institute of Medicine. (1989). *The responsible conduct of research in the health sciences*. Washington, D. C.: National Academy Press.

Jacobstein, J. G. (1989). Letter to the editor. *New England Journal of Medicine*, *320*, 57.

Langmuir, I. (1985). Pathological science: Scientific studies based on non-existent phenomenon. (1953 lecture, ed. by R. N. Hall). *Speculations in Science and Technology*. *8*(2), 77-94.

Lemonick, M. D. (1989, May 8). Fusion illusion? Time, pp. 72-77.

Longino, H. (1983). Beyond 'bad science': Skeptical reflections on the value-freedom of scientific inquiry. Science, Technology, & Human Values. 8(1), 7-17.

Merton, R. K. (1973). The sociology of science: Theoretical and empirical investigations. Chicago: University of Chicago Press.

Mulkay, M. J. (1976). Norms and ideology in science. Social Science Information, 15, 637-656.

National Academy of Science. (1989). On being a scientist. Washington, D. C.: National Academy Press.

Nelkin, D. (1982). Intellectual property: The control of scientific information. Science, 216, 704-708.

Nova. (1988). Do scientists cheat? Boston, MA: WGBH Educational Foundation/ WGBH Transcripts.

Oppenheimer, R. (1955). The open mind. New York: Simon & Schuster.

Peat, F. D. (1989). Cold fusion: The making of a scientific controversy. Chicago, IL: Contemporary Books, Inc.

Pool, R. (1989). How cold fusion happened--twice! Science, 244, 420-423.

Pool, R., & Heppenheimer, T. A. (1989). Electrochemists fail to heat up cold fusion. Science, 244, 647.

Relman, A. S. (1983). Lessons from the Dorsee Affair. New England Journal of Medicine, 308, 1415-1417.

Rothman, R. (1972). A dissenting view on the scientific ethos. British Journal of Sociology, 23(1), 102-108.

Saltus, R. (1989, May 2). MIT researchers report flawed data. The Boston Globe, pp. 1, 12.

Schmaus, W. (1983). Fraud and the norms of science. Science, Technology, & Human Values, 8(4), 12-22.

Swazey, J. P., & Scher, S. R. (1981). The whisteblower as a devient professional: Professional norms and responses to fraud in clincial research. in Swazey, J. P., & Scher, S. R., eds. Whistleblowing in biomedical research. Washington, D. C.: AAAS.

Tate, N. (1989, May 1). MIT bombbshell knocks fusion 'breakthrough' cold. Boston Herald, pp. 1, 4.

Teitelman, R. (1989). Gene dreams: Wall street, academia, and the rise of biotechnology. New York: Basic Books, Inc.

U. S. Congress. House. (1981). Committee on Science and Technology. Fraud in biomedical research. 97th Congress, March 31- April 1. Washington, D. C.: U. S. Government Printing Office.

U. S. Congress. House. (1990). Committee on Government Operations. Are scientific misconduct and conflicts of interest hazardous to our health? 101st Congress, 2nd Session, September 10. Washington, D. C.: U. S. Government Printing Office.

Wilmotte, R. M. (1970) Engineering truth in competitive environments. IEEE Spectrum, 7(5), 45-49.

Woolf, P. (1981). Fraud in science: How much, how serious? The Hastings Center Report, 11(5), 9-14.

Woolf, P. (1987). Ensuring integrity in biomedical publication. Journal of the American Medical Association, 258, 3424-3427.

Zuckerman, H. (1984). Norms and deviant behavior in science. Science, Technology & Human Values, 9(1), 7-13.

GREEN ECONOMICS AND THE DEVELOPING WORLD: INSTITUTIONAL STRATEGIES FOR SUSTAINABLE DEVELOPMENT

John Byrne Insook Han Jong-dall Kim
Young-Doo Wang Rebecca J.Wykoff
Center for Energy and Urban Policy Research
University of Delaware
Newark, De 19716
Tel: (302) 451-8405

Introduction

The crucial challenge facing developing countries in the 1990s is how to efficiently use energy while continuing economic growth in a manner that is economically and ecologically sustainable. Currently, half of all developing countries depend upon imported oil for more than 75 percent of their commercial energy needs. The energy crises of the 1970s demonstrated how costly such dependence can be for the developing world as trade deficits tripled and indebtedness rose by nearly a half-trillion dollars among oil-importing developing countries. Energy-related national vulnerabilities will only intensify if the traditional fossil fuel-based industrial development path is imitated.

Although the developing world consumes comparatively little of the world's annual fossil-fuel production, it would be a fundamental error to conclude that there is little to be gained by focusing on energy efficiency. The developing world is expected to substantially increase its need for commercial energy over the next 20-40 years. Assuring that this increase (estimated to be in the range of 4 to 6 terawatts) will be utilized in the most productive manner possible is in the direct economic and environmental interest of developing countries. But it is also of great value to the world community as a whole because it promises a more equitable and ecologically less destructive development pattern. An international priority to promote the spread of energy efficient technologies and strategies is the most sensible course for maximizing economic growth opportunities while minimizing the negative social and environmental effects of industrialization.

With rapid, energy-intensive economic growth, developing countries face acute environmental risks, with the poorest of its members confronted with a Hobson's choice: exhausting domestic energy sources (such as fuelwood) in the hope of material gain may merely set in motion forces of ecological destruction which challenge national abilities to feed their populations. The rapidly industrializing tier of developing countries face different, but no less serious, environmental dilemmas as air and water quality deteriorates in the urban boom areas, and public health is threatened. Yet, industrializing countries will need to increase energy consumption in order to sustain growth. At present, the industrialization process remains energy-intensive, especially in Asia, where carbon emissions have increased on average 16-17% per year. Thus, improving energy efficiency is vital to a sustainable environment and economy for developing countries, generally.

The achievement of energy efficiency in developing countries depends upon the adoption of an effective institutional framework for the direction of capital, technology and research toward the development of least-cost energy services and the removal of existing institutional barriers to greater energy productivity. Most developing countries lack the necessary means to invest in efficiency technology and will require the assistance of the industrialized community. Efforts to institutionalize energy efficiency in developing countries must incorporate technology transfer, economic aid and collaborative research programs between the industrialized and developing countries.

This paper first introduces the concept of sustainability in which environmental impact can be treated as a central concern in economic development — a so-called **Green Economics perspective**. The benefits of **Green Economics** over conventional development are presented. Then, the energy system required for sustainable development is examined. **Green Economics** depends upon the introduction of energy-environmental systems that are conservation-oriented. The approach presented here is based upon research focusing on the development issues and prospects of Asian developing countries.[1]

Benefits of Green Economics

Energy efficiency improvements engender substantial benefits in virtually all spheres of development: economic, social, political, technological, environmental, and planning. Enhanced flexibility in responding to energy needs, the reduction of vulnerability to supply disruptions, and the conservation of indigenous resources are positive outcomes of a sustainable energy system. Environmental quality is improved, and the conflict between energy demands and environmental values is diminished. In addition to direct benefits, energy efficiency and environmental protection yield positive societal impacts in the economic, social, technological, security, and planning arenas.

Economic Benefits

Energy efficiency can cut the cost of producing goods and services, thereby enabling developing countries to increase their industrial productivity and international competitiveness, as well as sustain their agricultural outputs. Efficiency improvements also can reduce energy imports, enabling developing countries to redirect capital to investments in sectors of the economy that may contribute to increased long-term economic growth.

Environmental Benefits

Improved energy efficiency results in substantial environmental benefits. Increasing efficiency, for example, reduces consumption of fossil fuels, and is the least costly, most effective, and quickest strategy for reducing CO_2 emissions (Fulkerson, et al., 1989 quoted in Hirst, 1989). In general, efficiency reduces the environmental impacts that result from intensive exploitation of energy resources. As a result, energy efficiency may reduce conflicts between the demands of energy systems and the protection of environmental values.

Social Benefits

Energy efficient and environmentally-sensitive decisions reduce the social costs of development. As energy efficiency improves and as environmental quality is enhanced, the social benefits of development can also increase. Improving energy services without increasing energy use, allows individuals and whole societies to meet energy needs at a lower cost, and frees resources to help meet other basic needs. This is particularly important for addressing the needs of the poor, who are least able to bear the burden of higher energy costs. Efficiency improvement thereby helps to ameliorate some of the inequities between the poor and the wealthy, and between developed and developing countries; these inequities in part are sustained and exacerbated by increased energy consumption and higher energy prices. Future generations can also benefit from energy efficiency, since they will share in the benefits of preserving resources and enhancing environmental quality. Pursuing energy efficiency and environmental protection as institutional priorities enables developing countries to maintain a balanced strategy of development that seeks both economic and social improvement. As a result, societal conflicts between economic growth and other social values may be reduced.

---

[1] This paper is based on a study conducted for the World Bank. The purpose of the study was to provide a framework for strengthening energy efficiency and environmental protection institutions in developing countries as the foundation for their pursuit of sustainable development. This study was conducted during 1990 and 1991 by a study team composed of researchers from three organizations; the Center for Energy and Urban Policy Research (CEUPR) of the University of Delaware; the Korea Energy Economics Institute (KEEI); and the Environmental Planning Institute (EPI) of Seoul National University. The research focused on the energy, environment and development situations of four Asian countries — Indonesia, South Korea, Malaysia and Thailand. See Byrne et al (1990) for details of this analysis.

Service and Technology Benefits

Energy efficiency improves energy services by substituting technologically superior products and processes for reliance on fuels. For example, installing improved weatherization, insulation, more energy efficient doors and windows may substantially reduce fuel demands for heating and cooling services in buildings, and may do so at a lower cost. (Hirst, 1989). More efficient energy services may be achieved for virtually all end-uses through the application of technologies that already exist: advanced electric heat pumps; more efficient refrigerators and freezers; high-efficiency electric motors; industrial cogeneration; new automotive engines; and new ballasts and lighting controls for commercial buildings. In most cases, the use of technology to improve the efficiency of energy services represents the least-cost option for meeting the energy needs of developing countries. Developing countries have opportunities to adopt more energy-efficient technologies as part of their overall strategy of development. This means that if they act now, they can, in many cases, create an institutional infrastructure for energy efficiency that will avoid the problem currently faced by industrialized countries. The latter can only achieve efficiency improvements by retrofitting the inefficient infrastructure established during earlier periods of development (Reddy and Goldemberg, 1990). Moreover, energy efficient technologies are likely to become the most competitive technologies in the future, and their choice by developing countries avoids the possibility of subsequent technological obsolescence.

Security Benefits

Most developing countries can enhance national security by lowering oil imports through efficiency improvements. For oil-importing developing countries, energy efficiency improvements lower foreign exchange costs. For oil-exporting developing countries, energy efficiency improvements increase their energy export opportunities and the value of their domestic energy resources. For all developing countries, energy efficiency promotes development independence, thereby decreasing dependency and external control.

Energy Benefits

Energy efficiency strategies add diversity and flexibility to the portfolio of energy resources in developing countries. Slowing the rate of energy demand growth through efficiency-oriented technology choice lessens the impact of energy supply/technology gaps and bottlenecks that invariably accompany rapid development. In expanding the level of services obtained from energy resources and technologies, efficiency strategies offer energy managers important tools to respond to the rapidly increasing demands by industry and other intensive energy users. Monies saved through energy efficiency can be invested to explore new indigenous energy resources. In these ways, energy efficiency strategies contribute to reducing the vulnerability of the energy system and the economy to changes in price and availability of energy resources.

Planning Benefits

Promoting energy efficiency and environmental protection creates new opportunities for national and regional planning. Incorporated into overall planning strategies, efficiency improvements may help developing countries to better anticipate, address, and possibly avoid problems that frequently accompany development: congestion of cities, uneven buildup of infrastructure, and regional disparities based on energy resource availability. For example, energy-efficient, environmentally-sound spatial planning for new city development may ease congestion problems, leading to lower transportation-induced air pollution levels in the future. Seeking energy efficiency improvements fosters a long-term approach to planning that emphasizes sustainability of development achievements.

The development benefits of energy efficiency and environmental protection are summarized in Table 1. For most developing countries, the opportunity to pursue energy efficient, environmentally-sound strategies is greater now than it will be in the future. Delaying or postponing efficiency decisions threatens to foreclose opportunities for the future. In addition, delaying decisions may compound long-term development problems, forcing more costly "retrofit" actions to catch up with efficiency requirements at a later date.

An Institutional Framework of Green Economics

Exploiting the benefits of energy efficiency and environmental protection requires an institutional transition guided by a different orientation to development that focuses upon sustainability (see Table 2). This orientation to development is a new, emerging one that has recently been endorsed by the U.N. sponsored World Commission on Environment and Development.

The conventional growth orientation that has been typical in Europe, North America, and most recently in Japan reflects the goals of material accumulation and profit maximization; and the institutional structures of these regions likewise reflect a distinctive growth orientation. In its applications to currently developing countries, this orientation encourages the replication (in some modified form) of past urban-industrial development.

A **Sustainable Development** orientation defines the current challenges to development in the context of worldwide conditions of energy resource depletion and environmental degradation. As the World Commission proposes:

> Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future. Far from requiring the cessation of economic growth, it recognizes that the problems of poverty and underdevelopment cannot be solved unless we have a new era of growth in which developing countries play a large role and reap large benefits. (World Commission, 1987: 40)

The concept of sustainability is founded upon the interaction and mutual dependence of society and the environment. Environmental impacts are to be treated as a central concern in economic decision-making, stressing the preservation of resources and patterns of growth which enhance long-term economic viability and environmental integrity. Economic growth remains a dominant goal of development in the sustainable model; however, improved efficiency in the use of energy and environmental resources is viewed as essential to long-term productivity, and future, as well as present, needs are considered to be of fundamental significance.

Sustainable development requires energy-environmental systems that are conservation-oriented; institutions that comprise these systems are responsible for developing and implementing the most energy efficient and least environmentally disruptive means to achieve desired social outcomes. Development is seen to result from the achievement of energy efficient, environmentally sensitive service improvements that are broadly distributed among the population. Such improvements contribute to a pattern of stable long-term growth across sectors of the economy. Technologies are selected on the basis of assessment of their end-use efficiency and their social and environmental costs. The orientation establishes a standard of achievement guided by the criterion of balanced, uninterrupted social and economic development of community rather than short-term material improvements subject to cycles of

Table 1
Development Benefits of Energy Efficiency and Environmental Protection

Economic Benefits

- Increases industrial and agricultural productivity
- Reduces capital requirements for meeting energy needs
- Supports sustained, long-term economic growth

Environmental Benefits

- Enhances environmental quality
- Reduces conflict between energy demands and environmental values

Social Benefits

- Reduces social costs of development
- Reduces inequities of energy burdens between economic groups
- Inter-generational benefits

Service and Technology Benefits

- Improves energy services at least cost
- Stimulates technology innovation
- Contributes to future technology competitiveness

Security Benefits

- Lowers foreign exchange costs for energy imports
- Increases value of domestic energy resources
- Promotes development self-reliance

Energy Benefits

- Enhances flexibility in responding to energy needs
- Preserves domestic energy resources
- Reduces vulnerability of energy system to supply disruptions

Planning Benefits

- Encourages anticipatory, least-cost planning of development
- Fosters planning for sustained, long-term development

Source: John Byrne et al., 1990.

Table 2
DEVELOPMENT MODELS

Conventional Growth Model	Sustainable Developmenmt Model
General	
■ Goal is profit maximization.	■ Goal is long-term growth/viability.
■ Commodity-oriented	■ End-use oriented
■ Consumption-driven	■ Consumption/conservation in balance
■ Resources are seen as "factors of production"	■ Resources are seen as limited, vulnerable, requiring stewardship
■ Resources-intensive, governed by economic priorities	■ Resource-conserving, governed by multiple priorities
■ Urban/industrial-based centers of production	■ Regionally dispersed centers of production
■ Economic costs are primary	■ Economic costs balanced by social and environmental considerations
Energy	
■ Fossil fuel-based	■ Greater use of alternative energy sources
■ Goal: to secure abundant, low cost supply	■ Goal: to secure end-use efficiency
■ Reduce vulnerability by diversifying sources of supply	■ Reduce vulnerability by reducing energy intensity
■ Energy/technology-focused	■ Energy/environmental conservation-focused
■ Efficiency in economic production - scale economy - technical efficiency	■ Efficiency in end-use/energy services - modularity - energy efficiency
Technology	
■ Large-scale	■ Small to moderate scale
■ Central/international system	■ Decentralization/locally responsive system
■ Technology choice is driven by industrial infrastructure needs	■ Technology choice is user-driven
■ Technical decisions governed by production/economic costs	■ Technical decisions governed by social/environmental costs
■ Limited technical options - those that fit are favored	■ Multiple technical options - those that create flexibility are preferred
Environment	
■ Ecological assumption - humans dominate the environment	■ Ecological assumption - humans/environment are mutually dependent
■ Environment is seen as an abundant source of commodities	■ Environment is seen as exhaustible, but sustainable resources
■ Environmental impacts external to economic choice	■ Environmental impacts central and internal to economic choice
■ Use-strategy: intensive, governed by economic profitability	■ Use-strategy: selective, governed by conservation principle to ensure - long-term economic viability - non-economic dimensions

Source: John Byrne et al., 1990.

growth and decline. In this context, the community value of equity in the distribution of wealth counterbalances the value of sudden additions to wealth-creation.

An Institutional Model For Energy Sustainability

The institutional differences between these two types of energy systems are fundamental and lead to divergent attitudes among energy decision-makers in the two systems. In the **Conventional Growth**-oriented energy system, energy decision-makers act on the premise that increased energy consumption equals economic growth. Decision-makers tend to emphasize the values of stability, supply reliability, and economic optimization; social and environmental impacts are treated as external to energy decisions. Energy choices are profit-oriented and technology-reliant with a focus on centralized, capital intensive systems of production and delivery capable of providing abundant fuel supplies to meet the requirements of industrial wealth-creation. These system goals guide and structure the characteristics of conventional growth-oriented energy institutions. National energy policy institutions tend to focus on production incentives, reliability-focused regulation, removal of some market imperfections, and standardization of technologies and delivery systems. Market institutions are characteristically supply-oriented, capital intensive and technology focused; prices reflect fuel competition among systems of production that tend toward monopoly or oligopoly. Technology institutions focus on the development of large-scale, centralized and interconnected supply systems that are responsive to the demands of the prevailing system of energy production and delivery. The character of energy decision-making in each case is responsive to a set of general system goals that become the standards for constructing particular institutional arrangements incorporating policy, markets, and technology (see Table 3).

The characteristics of policy, market and technology institutions are mirrored by energy-related aid institutions, financial institutions, and academic and research institutions. Energy-related aid institutions tend to concentrate on supply-oriented programs centered around proven technologies of industrial nations; aid strategies seek to achieve export maximization, to stimulate new technology and energy markets in aid-receiving nations, and to cultivate investment opportunities for multinational corporations in aid-receiving countries. Financial institutions tend to give priority to the capital needs of large investors (producers) supporting large-scale projects to maintain technology expansion.

By contrast, in a sustainable growth-oriented energy system energy decision makers act on the premise that energy efficiency equals sustainable development. Decision-makers tend to emphasize the values of innovation, flexibility, equity, and social optimization; social and environmental impacts are treated as internal to energy decisions. Energy choices are equity-oriented and community-reliant, with a focus on decentralized delivery of efficient energy services to meet requirements for sustained development.

The energy-environmental systems accommodated to sustainable development are conservation-oriented; institutions that comprise these systems are responsible for developing and implementing the most energy efficient and least environmentally disruptive means to achieve desired social outcomes. Development is seen to result from the achievement of energy efficient, environmentally sensitive service improvements that are broadly distributed among the population. Such improvements contribute to a pattern of stable long-term growth across sectors of the economy. Technologies are selected on the basis of assessment of their end-use efficiency and an assessment of their social and environmental costs. The orientation establishes a standard of achievement guided by the criterion of balanced, uninterrupted social and economic development of community rather than short-term material improvements subject to cycles of growth and decline. In this context, the community value of equity in the distribution of wealth counterbalances the value of sudden additions to wealth-creation.

Under a sustainable development orientation, the energy system goals concentrate on achieving end-use efficiency in the delivery of energy services. The goal of energy efficiency tends to incorporate a concern for integrated resource planning that evaluates a wide array of

Table 3
ENERGY INSTITUTION MODELS

Conventional Energy Institution	Efficient Energy Institution
System Goals	
Economic growth	Sustainable development
Abundant, low-cost energy supply	End-use efficiency
Mix of fuel sources	Enhanced self-reliance
Reduced vulnerability to world price change	Environmental maintenance
Institutional Goals	
National Energy Policy	
Production incentives	Efficiency incentives
Reliability-focused regulation	End use-focused regulation
Removal of market barriers (in some cases)	Creation of efficiency-environmental institutions
Expansion of demand	Expansion of end-use efficiency
Local adaptation to national choices	Local choices and responsibility
Standardization of delivery systems	Diversification of delivery systems
Energy Market	
Supply-oriented	Efficiency-oriented
Capital intensive and concentrated investment pattern	Diversified capital investment pattern
Fuel-based prices	Social/environmental cost-based prices
Emphasis on near-term rate of return	Emphasis on life-cycle costing
Balances supply and demand of fuel quantities	Balances supply and demand of energy services
Fuel competition	End-use competition
Technology System	
Large scale/technology-intensive	Small-to-moderate scale
Central/interconnected systems	Decentralized/locally responsive
Industrial infrastructure-driven technology choice	User-driven technology choice
Limited technology options	Diverse technology options
Engineering decisions based on production/economic costs	Engineering decisions based on social/environmental costs
Technology Transfer/ International Assistance	
Emphasis on export maximization	Emphasis on self-reliance
Transfer of proven energy technologies of industrial countries	Development of energy-efficient technology
Reliance on creation of commercial energy markets	Reliance on creation of end-use efficiency energy markets
Priority given to energy supply/production by international agencies	Priority given to end-use efficiency and service availability by international agencies
Finance (Public and Private)	
Priority given to capital needs of small number of large investors (producers)	Priority given to capital needs of large number of small investors (users)
Large scale projects favored	Modularity favored
Short- to near-term perspective	Long-term perspective
Focus on economic risks	Focus on social/environmental risks
Education, Research and Training	
Power/production engineering	Environment-sensitive engineering
Market/engineering economics	Social economics/least-cost analysis
Production/capacity planning	Integrated resource planning
Economic/technology forecasting	Policy studies/scenario analysis
Supply-side/technology management	Demand-side management
Environmental impact analysis	Environmental conservation analysis

Source: John Byrne et al., 1990.

supply and demand options for addressing energy needs. The energy system seeks to create conditions that support long-term sustainable development that is responsive to anticipated future energy needs as well as current energy demand. In the context of this longer-term perspective, energy system goals include a concern for enhancing self-reliance and maintaining environmental quality.

These system goals guide and structure the characteristics of sustainable growth-oriented energy institutions. National energy policy institutions concentrate on efficiency (rather than production) incentives, service-focused regulation, and the creation of new, diversified institutions, technologies and delivery systems to promote a wide array of least-cost energy services; technology choice is guided by the criteria of long-term efficiency improvement and resource conservation. Energy markets are innovation-oriented and responsive to competition among a diversity of low capital projects for delivering least-cost energy services; price reflect the social/environmental costs of service options and the competition among diverse service providers. Technology institutions focus on the development of numerous small-to-moderate scale, decentralized systems that are responsive to user needs rather than prevailing systems of production and delivery.

Energy related aid institutions tend to focus on the stimulation of self-reliance through service creation strategies and the development of efficient technology to meet indigenous needs; investment aims at strengthening the capacity of indigenous institutions. Financial institutions give priority to the capital needs of a large number of small investors in energy service improvements; finance decisions incorporate a long-term perspective on pay-back requirements and incorporate a concern for social/environmental (as opposed to purely economic) risks. Academic and research institutions tend to concentrate on requirements for integrated planning of a balanced strategy for efficient energy services that incorporates a concern for social/environmental impacts.

Sustainable development emphasizes energy systems that expand the use of alternative sources, focusing upon end-uses and efficiency. Conservation goals are reflected in technological systems which encourage the introduction of multiple technical options, favoring those that create flexibility in production and use, and are small to moderate in scale. Choice of technical systems is accorded to users, rather than defined by the structure of existing systems, and decisions are guided by social and environmental costs and considerations.

Sustainable development versus conventional growth models of development juxtapose energy and environmental concerns with economic considerations, and efficiency in the use of environmental resources with efficiency in the use of fiscal resources. The sustainable development technology which is characterized by small to moderate scale systems that are responsive to needs and flexible in use can be contrasted with conventional large-scale systems that define and circumscribe technical options. Finally, conventional growth embraces the goal of maximum profit, while a perspective of sustainability incorporates social/environmental costs of development.

While the goals of sustainable development are applicable to all countries, both developed and developing, the paths by which countries reach these goals will vary according to existing conditions and institutional frameworks. The process of development has been shown to require large and increasing amounts of energy as it accelerates and reaches a critical stage. Industrialized countries have surpassed this point, and currently face issues of realigning existing structures and relationships in light of new realities. Developing countries, however, confront a somewhat different kind of challenge. As demonstrated by East and Southeast Asian countries, industrialization has been attained in accordance with the urban-industrial conventional growth framework to varying degrees, and different strategies may be required in each to alter existing relationships and adopt sustainable priorities. However, all continue to share the need for growing levels of productive energy to support development objectives in a world in which environmental preservation and energy conservation have become crucial.

The developing countries are also presented with several advantages and opportunities in guiding and adapting development in ways that recognize energy and environmental sustainability as societal goals.

Major Institutional Barriers

Given the fundamental differences between the conventional growth and sustainable development orientations, a crucial challenge facing developing countries is making the transition from a conventional to a sustainable energy system. Information collected through research and policy literature, reports of international agencies, and interviews with officials of the energy environmental ministries of selected Asian countries, identified two common types of barriers: structural and behavioral. Structural barriers are defined as conditions that are beyond the control of the individual end user. To overcome this type of problem, it may be necessary to focus on needs for new institutions and policies that will encourage systematic development of energy efficient, environmentally sensitive technologies and approaches. Behavioral barriers are defined as problems that characterize the end-user's decision making. To overcome these barriers, change is necessary at the policy level which involves a strengthening of the capacities of existing institutions to meet new responsibilities. These barriers and policy responses to them are summarized in Table 4. The most important barriers within the existing institutional arrangements can be classified into four categories.

1. Lack of institutional capacity for enforcement of current policies: The experiences of selected Asian countries show that the major barriers to successful implementation of energy-efficiency programs are: 1) the lack of stable and continuous financing for energy-efficiency; 2) the lack of qualified personnel; and 3) a lack of equipment for energy auditing, testing, and monitoring.

2. Lack of incentives to conserve energy: According to the experiences of the Asian study countries, distortions in fuel price and misplaced incentives are the major problem areas in this category.

3. Lack of systematic feedback and evaluation of existing efficiency efforts: Our research in Asia reveals that systematic feedback and evaluation of existing efficiency efforts can encourage positive activities towards energy efficiency programs.

4. Uncertainty of energy consumer behavior: Our research also documents the need for promotional activities and demonstration programs to promote energy efficiency programs, and overcome consumer misconceptions.

Perhaps most important, our analysis indicates that energy-efficiency program successes depend on the degree of government commitment. For example, the Malaysian government provides limited funding, staff, and internal research capacity devoted to energy efficiency programs and policies, and as a result, mechanisms to implement and monitor efficiency measures are largely absent. For this reason, Malaysia has few energy-efficiency program successes. By contrast, the Korean government's strong commitment to energy conservation is evidenced in its comprehensive activities on energy efficiency, and the comparatively greater gains in energy conservation, especially in its industrial sector.

Institution Building

An energy system appropriate to sustainable development has a number of distinctive institutional requirements that are different from those of the conventional growth-oriented system. Since a sustainable development system focuses on decentralized delivery of efficient energy services to diverse users, there is an important institutional demand to broadly disseminate public information on energy options and their end-use efficiencies. In addition, the internalization of social/environmental impacts in the choice among energy options creates

TABLE 4
Policy Options to Address Barriers to Improved Energy Efficiency

Barriers	Possible policy solutions
Distortions in fuel prices	Increase fuel taxes Strengthen pollution controls Eliminate tax benefits for fuels production Adopt utility rate regulations which encourage energy efficiency Establish energy pricing policies on the basis of social/environmental costs
Uncertainty about future fuel prices	Publish fuel-price forecasts
Limited access to capital	Offer financial incentives for energy-efficient systems Provide tax credits for efficiency investments Create a public loan fund specifically to finance small- to medium-scale investments in energy efficiency
Government fiscal and regulatory policies	Increase government funds for energy-efficiency research and programs Require energy-efficiency/environmental impact reviews of major fiscal and regulatory policies
Codes and standards	Accelerate code setting and revisions Adopt energy-efficiency codes and standards
Supply infrastructure limitations	Require government procurement of efficient products and systems Offer energy-efficiency programs with utility, industry and transport sector participation
Attitudes toward energy efficiency	Conduct public information programs Provide visible leadership from top government and business officials
Perceived risk of energy-efficiency investments	Conduct demonstration programs Provide performance-contracting services Establish labelling and rating programs
Information gaps	Conduct information and training programs Establish labelling and rating programs Conduct model energy audits of typical buildings and industrial plants Mobilize educational and research institution support to address end user concerns
Misplaced incentives	Conduct information and training programs Strengthen codes and standards Offer financial incentive programs

Source: Eric Hirst and Marilyn Brown, 1990.

an additional institutional requirement for wider community participation in energy choice than is the case under the conventional growth-oriented system. Moreover, the concern for the interdependency of energy choice with environmental protection requires new environmental institutions aligned with energy institutions which are predicated on conservation principles.

Three areas of institutional development can be identified as helpful starting points for building long-term national support of sustainable development:

- Integrated Energy-Environment Planning
- Training Programs in Energy-Efficiency and Environmental Protection
- Regional Cooperation in Energy and Environmental Planning

Effective integration of energy and environmental planning will place needed information and analysis in the hands of energy and environmental policy makers. Integrated planning allows policy makers to replace plans based solely on forecasted energy needs with systematic scenario analyses of environmentally sensitive, energy efficient development. In the context of such analyses, decision makers can define the appropriate balance among end use, environmental, and supply considerations in the energy sector. Such plans can also incorporate criteria for choosing among energy technology options that are consistent with the goal of sustainable development, and establish mechanisms to ensure environmental impact assessments in energy planning and evaluation.

Enhancing institutional capacities and linkages requires up-to-date knowledge of environmentally sensitive, energy-efficient technologies and strategies. Engineers, planners and decision makers need training resources comparable to those available for conventional energy options. Such training programs enhance national institutional capacities and improve access to international knowledge resources. A first step in the development of enhanced training programs, national resources in universities, research institutes, industrial laboratories, and other institutions need to be effectively utilized and coordinated. In addition to strengthening the indigenous training capacities and knowledge resources, international resources should be better mobilized to serve the needs of developing countries. One possibility that should be explored is the creation of an Energy and Environmental Conservation Institute funded by international agencies to provide training and access to policy, planning, and engineering information. This institute, in addition to strengthening training capacities and access to knowledge resources, can facilitate regional research and planning cooperation.

Several issues need to be addressed in establishing a framework for successful promotion of regional cooperation. In the short-term, existing networks of relationships among developing countries may provide the most appropriate vehicle for extending regional cooperation on energy efficiency and environmental protection. Using existing networks, however, raises the possibility that energy efficiency and environmental protection goals may be overshadowed by other priorities or may be pursued only as an embellishment of other objectives in regional cooperation. Over the longer term, developing countries should evaluate the desirability of a new regional cooperation body specifically designed to promote regional goals of energy efficiency and environmental protection as part of an overall strategy of sustainable development. That evaluation should also consider ways to include industrialized countries as partners in regional programs to promote energy efficiency and environmental protection.

Conclusion

With many developing countries experiencing rapid energy- and environment-intensive economic growth, it is a critical time for efforts to secure an affective institutional framework to promote sustainable development. Successful institutionalization of an energy-efficient, environmentally sensitive development strategy will empower developing countries to advance their social aims while avoiding many of the security, pollution and inequality dilemmas that have accompanied conventional industrial development.

References

Byrne, John et al. (1990) *Institutional Strategies for Energy Efficient and Environmentally Sensitive Development.* Prepared for ESMAP/World Bank.

Hirst, Eric and Marilyn Brown (1990) *Closing the Efficiency Gap: Barriers to the Efficient Use of Energy* (January). Oak Ridge, TN: Oak Ridge National Laboratory.

Hirst, Eric (1989) *Federal Roles to Realized National Energy-Eficiency Opportunities in the 1990s* (October) Oak Ridge, TN: Oak Ridge National Laboratory.

Reddy, Amulya K. N. and José Goldemberg (1990) "Energy for the Developing World," *Scientific American*, Vol. 263: 110-119.

World Commission on Environment and Development (1987) *Energy 2000: A Global Strategy for Sustainable Development.* London: Zed Books Ltd.

ENERGY AND PLANNING: CERTAINTIES IN AN UNCERTAIN WORLD

John Byrne and Constantine Hadjilambrinos
Center for Energy and Urban Policy Research
University of Delaware
Newark, DE 19716
Tel: (302) 451-8405

Steven M. Hoffman
Department of Political Science
University of St. Thomas 55105
St. Paul, MN 55105
Tel: (612) 647-5670

Introduction

The oil crises of 1973-1974 and 1979-1980 had an impact far more lasting than the significant increase in oil prices through which they were manifest: they signaled the casting aside of all the "certainties" on which energy planning had been based. The uncertainties introduced in the planning process are not confined to primary fuel price instabilities and unpredictability of supplies, but, more significantly, they include the unfounding of some of the most basic principles of energy planning. The long held and deeply embedded belief that economic growth is tied to growth of energy consumption, was cast into doubt as the aftermath of the crises saw a changing ratio of energy usage per unit of economic output resulting from conservation efforts. The possibility emerged that economic growth may be possible without a corresponding growth in energy consumption and forecasting of energy needs based on projected economic development became risky if not impossible (Flavin, 1984). Furthermore, the inflation fraught forth by the oil price increases placed such a high cost on capital that large-scale, capital-intensive projects became increasingly unattractive.

The 1980's saw an increase in concern over the environment due to the emergence of environmental issues of global dimensions. Global climate change, acid rain and stratospheric ozone depletion, have all contributed to the realization that the ecosystem of our planet is vulnerable to human activity. The prevailing patterns of energy consumption contribute significantly to these problems. The complexity of the ecosystem and the global or regional scale of such problems prohibit the determination of their impacts with any high degree of certainty.

On April 26, 1986 what the community of "experts" claimed to be "virtually impossible" happened: reactor No. 4 at Chernobyl experienced a core meltdown. The Chernobyl disaster enforced the public's distrust towards the nuclear power industry and made the further development of nuclear power uncertain. Moreover, the continuing lack of a socially acceptable permanent solution to the radioactive waste disposal problem in the U.S. and other nations places even greater uncertainties on the future of commercial nuclear power.

There is little doubt that the environment for energy planning will remain as fraught with uncertainties in the 1990's as it was during the 1980's. If a new direction is not taken, one which would make possible a significant change in the present pattern of energy consumption, the uncertainties will not be over the occurrence of particular (highly unpleasant, to say the least) events, but, rather, over their magnitude, frequency and timing. Such uncertainties include:

1) the rate at which energy requirements will increase;
2) the acceleration curves and catastrophe points for global environmental threats such as the greenhouse effect and acid rain;
3) the point at which we will run out of affordable oil, at which we will have to stop burning coal, as well as the interval before and the seriousness of the next nuclear accident, the next tanker spill, the next gas pipeline rupture;
4) the rate at which energy prices will increase and the social and economic impact such increases will have;
5) the timing and location of the next famine which will visit the developing world and where and which country will next experience economic collapse; and
6) the political and social changes which will be necessitated by continuing reliance on large-scale, highly centralized modes of energy production.

Uncertainties of this type have been the target of research and analysis for years. Often the motive for investigating them has been to defend the present as a basis for organizing the future. That is, the concerns raised by uncertain events is that our current way of doing things may be disrupted. Focusing on such concerns necessitates planning approaches which emphasize prediction as the antidote. Treating uncertainty as a problem of prediction, however, underestimates the possibility that the improbable will happen.

Prediction can only be based on factors which are presently known. It is an extrapolation of the present into the future. More accurate prediction is predicated on the effective limitation of future events to only those "visible" from the present. Unforeseeable events can hardly be accounted for in a prediction-oriented planning scheme and are, therefore, to be avoided as much as possible.

When such planning schemes are oriented towards the determination of costs and benefits (as is almost always the case) the value of unforeseeable events cannot be calculated and is, therefore, ignored. Furthermore, the value assigned to various "possible" events is directly related to their calculated probability (see, for example, Evans & Hope, 1984). These planning methods thus tend to underestimate the costs and benefits of improbable events. When the unforeseeable and the improbable truly entail minor costs for being wrong we can live with our mistakes. But in the energy-environment-development interrelation, there are fewer and fewer permissible mistakes of this kind.

Certainties in an Uncertain World

While it is the *uncertainties* mentioned which have shaped energy policy in the previous two decades, a number of *certainties* have become apparent and it is they that must direct energy planning for the future. These certainties are the most important issues we face, for they are manifestations of characteristics of our future on which we can act now. Indeed, if we fail to act based on these certainties, or are ineffective in our actions, these characteristics are what will constrain our options for the future. Although there are many candidates for a possible list of ***energy certainties***, we believe that six can be generally agreed upon:

FIRST: World commercial energy requirements will increase, if for no other reason than to meet the development needs (and rights) of Asia, Africa and Latin America. The mid-range projection by the Institute for Applied Systems Analysis estimated that energy needs of developing countries would triple by 2020, from the 1980 level of 3.3 terawatts, to over 9.2 terawatts. World Resources Institute recently projected only a doubling of the energy needs of these countries by 2020, but even so this would mean an increase of 4.1 terawatts. This means that world energy use will increase by roughly 40 percent at the very least (see Wang, et al., 1988).

SECOND: World pollution levels will continue to increase while societies depend upon fossil fuel combustion for most of their energy needs. Several global environmental consequences derive from dependence upon fossil energy: from the visible disasters of the sliming of Prince William Sound to less immediate but far more dangerous perils such as global climate change. With regard to the latter, James MacKenzie of World Resources Institute (1987) notes that measurements at Mauna Loa, Hawaii Observatory over a 30-year period show a continuous climb in atmospheric CO_2 levels (CO_2 is the principal contributor to the greenhouse effect, see Table 1). This increase is part of a longer-term trend which has resulted in a 25% rise in the level of atmospheric CO_2 since the mid-19th century. While considerable uncertainty exists over the magnitude of global warming and over regional climatic changes, the U.N. sponsored Intergovernmental Panel on Climate Change reports that there is virtual unanimity among greenhouse experts that a warming is on the way and that the results will be serious, if not catastrophic. A doubling of pre-industrial concentrations of CO_2 – which will accompany the doubling of world energy use unless we change our fuel mix substantially – will increase global temperature between 1.5° and 4.5°C by the middle of the next century. The "best guess" estimate is a rise of 2.5°C. The warming effect is already on the way as an increase of the average global temperature of between 0.3° and 0.6°C since the late 19th century is apparent (Kerr, 1990: 481).

THIRD: The principal source of increased energy demand and world environmental pollution is, and will continue to be, industrialization. Industrialized countries are the largest contributors of CO_2 buildup. They also supply the greatest amounts of air-borne sulphur oxides, nitrous oxides and volatile organic compounds necessary for the formation of atmospheric ozone (O_3). While developing countries will increase their pollution contributions, and perhaps their share of world environmental degradation, this will be a derived result of two things: (1) the continued exploitation of their resources and peoples by the already-industrialized; and (2) the dictated development path they will follow to achieve parity. Choice in this matter is greatly restricted by the entrenched political, economic and technological power of the already-industrialized.

FOURTH: The combined trends of industrial growth, increased energy requirements, and rising pollution are unsustainable at the global level and have and will continue to engender pressure for change. It is very difficult to achieve consensus on the definition of sustainability and significant controversy surrounds the characterization of the development-energy-environment interrelationships. But while we may argue over these particulars, there does seem to be a growing awareness that whatever we mean by our terms, and however we model the relationships, the existing order of things is problematic and its viability is in doubt.

The present distribution of financial and industrial power is at the center of world problems of unsustainability. The productive and reproductive capacities of the world economy presently assume pervasive inequality. Such inequality, as the World Commission on

TABLE 1
Contribution of Various Gases to the Greenhouse Effect

Species	Concentration (ppbv)	Rate of increase (%/yr.)	Relative Contribution (%)
CO_2	$353x10^3$	0.5	60
CH_4	$1.7x10^3$	1	15
N_2O	310	0.2	5
O_3*	10-50	0.5	8
CFC-11	0.28	4	4
CFC-12	0.48	4	8

*In the troposphere.
From Rodhe, 1990: 1218.

TABLE 2
Trace metals released to the environment (Thous. Tonns/Year)

Element	Energy Production	Total	Energy as % of total
Antimony	1.30	3.5	37
Arsenic	2.22	19	12
Cadmium	0.79	7.6	10
Chromium	12.7	31	41
Copper	8.04	35	23
Lead	12.7	332	4
Manganese	12.1	38	32
Mercury	2.26	3.6	63
Nickel	42.0	52	81
Selenium	3.85	6.3	61
Thallium	1.13	5.1	22
Tin	3.27	5.1	64
Vanadium	84.0	86	98
Zinc	16.8	132	13

From Nriagu and Pacyna, 1988: 136.

Environment and Development has observed, forces the poor to become partners in environmental degradation (1987: 67-68):

> International economic relationships pose a particular problem for poor countries trying to manage their environments, since the export of natural resources remains a large factor in their economies, especially those of the least developed nations. The instability and adverse price trends faced by most of these countries make it impossible for them to manage their natural resource bases for sustained production. The rising burden of debt servicing and the decline in new capital flows intensify those forces that lead to environmental deterioration and resource depletion occurring at the expense of long-term development.

FIFTH: Addressing inequality must have our highest priority. But as we make changes in the world political economy, we will also have to act on two sectoral logjams – those in electricity and transportation. Both sectors will be the focus of world pressures for change. This is not to suggest that other sectors won't also be required to change; indeed, change is likely to be widespread, particularly if certain planning regimes are adopted (which are discussed below). But the utility and transportation sectors are central hubs in the industrial network: they play a fundamental role in determining the type of economic development we enjoy, the nature and amount of energy we produce and utilize, and, most important, the environmental waste stream we generate in sustaining a certain way of life. If industrial societies account for most of the world's pollution, these two sectors are the principal suppliers. Electric utilities in the U.S., for example, are the major sources of atmospheric CO_2 and SO_2 generating, respectively, 33% and 65% of these pollutants. This waste comes mostly from the burning of coal. Transportation runs a close second on CO_2 at 31% (from oil combustion). And this sector is the leading supplier of carbon monoxide at 70%, of nitrous oxides at 41% and of volatile organic compounds also at 41% (MacKenzie, 1987). Furthermore, energy production is responsible for a significant portion of the pollution of air, water and soil of hazardous metals (Table 2). Although trace metal pollution has not made the headlines that the greenhouse effect and acid rain have, it is a serious environmental threat. Once released into the environment, trace metals cannot be removed and do not decay but can enter the food chain posing serious long-term health hazards to animals and humans.

SIXTH: Change will be required at all organizational levels from city to nation, but most importantly, at the international level. This is made necessary by the scope of the environmental problems and the emerging global economy. Global climate change induced by human activity will clearly affect everyone. Stratospheric ozone depletion, mainly caused by industrial activity in the temperate north, affects most strongly the arctic regions. Acid rain is deposited mostly outside the borders of the nations responsible for the sulfur and nitrous oxides that cause it (French, 1990: 31-37) (Table 3). Trace metals are carried across borders by the winds, rivers and the sea. These problems can only be addressed in the context of international cooperation and by the development of new planning processes. The U.N. Conference on Electricity and Environment now being planned for 1991 in Helsinki is a step in the right direction; a similar endeavor on Transportation and the Environment is equally needed.

Planning for a Sustainable Energy Future

The six certainties discussed indicate that the energy planning process must change substantially. Planning for a sustainable energy future must be based on the following principles:

TABLE 3
Sulfur Pollution in Selected European Countries, 1988[1]

Country	Total Emissions[2]	Total Deposition	Share of Emissions Exported[3]	Share of Deposition Imported
	(thousand tons)		(percent)	
Norway	37	210	76	96
Austria	62	181	74	91
Sweden	110	302	69	89
Switzerland	37	65	81	89
Netherlands	145	104	80	72
France	760	622	67	59
West Germany	750	628	63	56
Czechoslovakia	1,400	659	75	47
Poland	2,090	1,248	68	46
Soviet Union[4]	5,150	3,201	61	38
Italy	1,185	510	72	36
East Germany	2,425	787	75	22
Spain	1,625	590	72	22
United Kingdom	1,890	636	71	15

[1] Sulfur is generally emitted as sulfur dioxide but may fall to earth as a variety of its chemical derivatives, including sulfuric acid and sulfates.

[2] Unless otherwise noted, emissions figures are preliminary 1988 data. Data for Austria, Sweden, and France are for 1987; Italy, 1986; and Spain, 1983.

[3] May be deposited either in another country or over a body of water.

[4] Only the European part of the Soviet Union; thus, export figure includes exports to the Asian part of the Soviet Union.

Source: Worldwatch Institute, based on emissions data in Economic Commission for Europe, "Annual Review of Strategies and Policies for Air Pollution Abatement" (draft), September 26, 1989, and on data on transboundary flows supplied by the European Monitoring and Evaluation Program.

1) Inequality, both at the national and international levels must be eliminated. The economic development of developing nations is essential.

2) For the path of sustainable energy development to be pursued, the global political-economic system must be changed. Only such a change will make it possible for long-term planning to take precedence over actions leading to only short-term gains.

3) Since the development path of all nations is dependent on the path chosen by industrialized nations, particularly the leading industrialized nations, it is they who must initiate the necessary changes.

4) The fundamental characteristic of the new global political economy and, particularly, the new planning philosophy, is co-operation. Only if the present spirit of competition is replaced by a reliance on co-operation will it be possible for equity to prevail and for both the industrialized and developing nations to attain the goal of sustainable development.

The new planning approach must not only recognize the unpredictability of the future but must incorporate it as an essential feature. Change must be recognized not as exogenous to the planning process and a threat, but as an endogenous condition of organizational growth and viability. It is only in this way that the necessary changes can be made possible and that the new structures created will be prevented from becoming as inflexible and, thus, as inadequate as those they must replace.

Fortunately, the necessity for such a planning approach is beginning to be recognized. The International Institute for Applied Systems Analysis (IIASA) has begun exploring the implications of long-term, environmentally conscious planning methods. Its project, titled ***Future Environments for Europe: Some Implications of Alternative Development Paths***, seeks to provide an organizational framework for decision-making attuned to conditions of uncertainty and oriented towards preventing (rather than responding to) environmental problems. This planning approach does not focus on predicting the future but, rather, on developing methods for managing the present so as to prevent a future fraught with adverse shocks to society. The methodology developed includes three components: scenarios, assessments and policy responses. Plausible (as distinct from probable) scenarios are generated in order to explore the range of possibilities. Appropriate socioeconomic, political and environmental "early warning" indicators are developed in order to assess the characteristics of future environments (as described by the scenarios). In this way diachronic policy dilemmas emerge and informed, long-term planning is made possible (Stigliani et. al., 1989).

A few U.S. utilities have begun to recognize the need for a new planning method:

> Unforseen event of the last two decades have transformed electric utility planning from simple forecasting of future load and resource requirements to planning for a future that is uncertain and unpredictable. Our future business environment will be shaped by regulatory, economic, technological, social, and political forces which have yet to unfold (Southern California Edison Co., 1988: 119).

The approach they have taken also relies on the use of scenarios to explore a range of possible futures. Focusing on the consequences of scenarios rather than the events or scenarios themselves, a wide range of possibilities is explored in order to develop a flexible action plan. Flexibility is assured through the inclusion of all the resources available to the utility – i.e., the development of an integrated resource plan. Inventorying the resources available within a wide range of conditions allows the utility to use the most appropriate measures to satisfy the demands placed upon it by its customers, as well as the emerging regulatory environment.

It is clear that a shift in the focus of energy planning is necessary if it is to be meaningful within the changing environment. Such change-dominated planning implies learning as the proper response to uncertainty. This leads us to a planning philosophy in which uncertainty evokes a sense of opportunity rather than threat. In this direction, energy and development structures which are fixed in the present become the objects and even the agents of transformation in the future. It is clear that thinking of this kind is essential if we are to address the unsustainable trends dominating the contemporary world economy. The recently concluded Economic Summit in Paris and Soviet President Gorbachev's extraordinary proposal to begin a process of economically linking East and West are welcome steps toward international cooperation. A healthy skepticism will and should accompany these pronouncements until substantive actions are undertaken. In this vein, the Brundtland report provides one of the clearest and best reasoned frameworks for international action.

This philosophy entails a three-dimensional approach to planning: planning as prediction, planning as change, and planning as learning. Each of these dimensions is a reflection of understanding the goals and methods of the enterprise as a generic social activity. Prediction in the form of scenarios seeks to expand rather than confine (as traditional forecasting sought to do) the range of possibilities. Essential in taking advantage of this expanded range of possibilities is the availability of the widest possible range of "instruments" (such as physical assets, policies, social structures etc.) through which to act. Expanding the inventory of such means requires that problems are viewed holistically and that traditional boundaries between policy areas be dropped. Only when the connections are realized between, for example, air, water and soil pollution, roads and railroads, electricity production and house building, to name a very few, can innovative solutions be found for the problems facing us. Finally, the problems should always be posed in the form of "who do we want to be" and "how can we change for the better," realizing that change is inevitable.

These suggestions are not specific about the substantive purposes of a plan. But the six certainties outlined above make amply clear the need to focus on specific goals. Two undeniable aims of planning will have to be:

1) to safeguard the environment for the future; and

2) to avoid, as far as possible, social and environmental trends which jeopardize our capacity to choose among a rich range of alternative, sustainable futures.

These goals propel us into a world of problems which typically have gestated for very long periods of time and which will require long-term attention to solve or abate. In a spring 1986 article in the American Planning Association Journal, Bruce Tonn of Oak Ridge labeled these phenomena "500 year problems" and called for 500 year planning to cope with them. Many would argue that a 500-year plan is an extravagance which we cannot afford, given our present dangers. On the other hand, unless we consider both the genesis of our problems and their solution in a time frame which recognizes present economic, political and technology systems as not only transformable but transitory, we are unlikely to penetrate the reproduction cycle of our certain dilemmas.

REFERENCES

Evans, N., & Hope, C. (1984). Nuclear Power: Futures, Costs and Benefits. New York, Cambridge University Press.

Flavin, C. (1984). Electricity's Future: The Shift to Efficiency And Small-Scale Power. Worldwatch Paper 61. Washington D.C.: Worldwatch Institute.

French, H. F. (1990). Clearing the Air: A Global Agenda. Worldwatch Paper 94. Washington D.C.: Worldwatch Institute.

Kerr, R. A. (1990). New Greenhouse Report Puts Down Dissenters. Science, 242, April 3, 1990, 481-482.

MacKenzie, J. J. (1987). The Greenhouse Problem, Air Pollution, Energy Security: The Linked Issues. Energy Policy Colloquium Speech (October 16). Transcript available from the Center for Energy and Urban Policy Research, University of Delaware, Newark, DE 19716.

Nriagu, J. O., & Pacyna, J. M. (1988). Quantitative Assessment of Worldwide Contamination of Air, Water and Soils with Trace Metals. Nature, 333, 134-139.

Rodhe, H. (1990). A Comparison of the Contributions of Various Gases to the Greenhouse Effect. Science, 248, June 8, 1990, 1217-1219.

Southern California Edison Company, Systems Planning and Research. (1988). Planning for Uncertainty: A Case Study, Technological Forecasting and Social Change, 33, 119-148.

Stigliani, W. M., Brouwer, F. M., Munn, R. E., Shaw, R. W., & Antonovsky, M. (1989). Future Environments for Europe: Some Implications of Alternative Development Paths. The Science of the Total Environment 80. Report also available from International Institute for Applied Systems Analysis, Laxenburg, Austria.

Tonn, B. E. (1986). 500-Year Planning: A Speculative Provocation. APA Journal, Spring, 185-193.

Wang, Y., et al. (1988). Energy Needs for Economic Expansion in the Developing World: Trends in the Energy-Development Relationship. In Heinonen, J., et al. (Eds.), Proceedings of the International Symposium on Energy Options for the Year 2000, 4, 4.109-4.116. Newark, DE: Center for Energy and Urban Policy Research, University of Delaware.

World Commission on Environment and Development (the Brundtland Report). (1987). Our Common Future. New York, NY: Oxford University Press.

ELECTRONIC INEQUALITY

Thomas W. Simon
University of Baltimore
1420 Charles Street
Baltimore, Maryland 21201-5779
(301)-234-3933

Participatory Democracy and Computer Technology

The vision and practice of direct participatory democracy has persisted throughout the history of Western political philosophy. The New England town meeting stands along side the Athenian assembly as models of true democracy. In the 1960's and 1970's participatory democratic theorists and activists relied heavily on the Athenian and New England models, and in the 1980's republicanism/communitarianism proponents rejuvenated these concerns for self-government. Recently, however, a new technocratic version of the participatory dream has emerged. Instead of entering the Athenian assembly, people fulfill their obligations as citizens through new electronic devices that enable all citizens not only to express themselves on policy issues but also to play a direct role in deciding those issues. Every modern proponent of participatory democracy has had to face the obstacle of the complexity and size of the modern state to the realization of the participatory democratic vision. Technology comes to the rescue. The speed and wizardry of computers enable large numbers of individuals to participate in a wide array of political decisions. Modern citizens sit in the Athenian assembly of their homes armed with laptop computers.

The image of citizens directly participating in the affairs of, what can be truly called "their government," takes on a new life in a technological context. Technology delivers the fulfillment of the participatory dream in the form of teledemocracy. Technology overcomes the problems of complexity and size. Technology makes ancient Athens possible today.

While not wanting to completely dismiss the progress that technology has made on the democratic frontiers, I will try to show that the technocratic version of the participatory dream will remain largely empty unless theorists circumscribe the vision with a normative social theory of democracy. Arterton, in his study of teledemocracy projects, addresses the relationship between a social theory and participatory democracy:

> The inequalities of participation across social groups... should be a matter of grave concern, for they constitute an empirical refutation of our deepest convictions of appropriate government: 'of the people, by the people, and for the people' (Arterton 1987, 210).

I would put this point in even stronger terms. Grave inequalities across social groups completely undermine the practice of participatory democracy, since participation presupposes a particular degree of levelling of the playing field for all citizens. The impoverished and the racially oppressed constitute two, often times overlapping, groups at the lower end of the social spectrum. Almost all versions of democratic theory, including participatory theory, fail to incorporate a concern for groups like these as a central tenant of their theories. Democratic theorists most often talk about the majority and the minority in a numerical but not in a social sense. Accordingly, the fact that a minority comes from a particular class or group remains incidental to the main claims of the theory. Yet, every democratic theory promotes some degree of political participation on the part of the citizenry. Unjustifiably excluding or structurally diminishing the effectiveness of certain groups undermines the participation promoted by the system.

Following the trail blazed by fellow democratic theorists, teledemocracy enthusiasts steadfastly refuse to address, except for some hand waving gestures, the serious problem of social inequality. Failing to confront social inequality causes teledemocrats to focus on the wrong problem. The danger that technology poses for democracy does not lie in the potential restrictions on First Amendment freedoms or on values such as autonomy. Rather the most critical danger lies in the potential for technology to widen the gap between social groups, all in the name of democracy. Similarly, complexity and size do not offer the biggest obstacles to participatory democracy; social inequality constitutes the major stumbling block. The primary problem confronting participatory democracy does not lie in the engineering realm of constructing the most effective tools for democracy but rather in the conceptual/praxis realm of devising the most adequate theory of and practice for democracy.

Although disagreements run rampant throughout discussion of democracy, most theorists agree that political democracy, i.e., democracy as a method or procedure, is the requisite condition for all other versions of democracy, such as economic democracy, industrial democracy, or social democracy (Sartori 1987, 11). I want to claim just the opposite: social democracy, i.e., democracy in the social sense, as a state of society, should serve as as a primary concern for all other forms of democracy. By a "social theory," I mean a historically informed assessment of the political, economic, and social status of groups and of individuals within those groups. Participatory democracy or any other version of democracy ought to first and foremost engage in the process of trying to overcome oppression and domination in all institutions and practices where unjust power relationships prevail. Any attempt to enhance participatory activity among the citizens needs to first confront the problem of social stratification, of how people become differentially situated with respect to power. Accepting wide disparities in the placement of the starting gates subverts rather than advances participatory democracy. Unfortunately, teledemocracy takes far too much disparity among groups of citizens as given (Laudon 1977). By not accounting for social inequalities teledemocrats will undoubtedly exacerbate the "participatory gap" between rich and poor, blacks and whites, etc.

The middle and upper echelons of our society have ready access to computer technology; the lower echelons do not. It should therefore come as no surprise that many attempts to enhance democracy through the use of computers fail to broaden the democratic base in any significant way. Teledemocrats have not received this message.

The Politics of Teledemocracy

Teledemocracy advocates have a limited conception of participation. As participants in the political process citizens have preferences, debate issues, and vote. Every theory of democracy includes these activities, yet citizenship extends far beyond these boundaries. Citizens relate to the state in many ways, including activities that do not center around voicing an opinion through traditional channels or voting. Protest activity, for example, should qualify as a highly participatory activity. Through protest citizens exhibit a high degree of involvement in and concern for the affairs of the state. In many instances, protest activity far outstrips voting according to almost any conceivable measure of participation.

The exclusion of protest activity from teledemocracy schemes serves as an important challenge. Protest serves as a vehicle for many different kinds of groups, but it is especially important for those social groups who are barely allowed on the playing field of democratic governance. I do not know of any discussions in the literature about developing technologies so as to amplify the voices of protest or addressed to primarily improving democratic access for the disadvantaged.

Admittedly, some teledemocracy projects enhance the ability of some people to voice opinions. The Des Moines Health Vote of '82 gave a fairly broad spectrum of citizens some say over priorities on health care policy. However, the vast majority of teledemocracy projects do not allow for citizens to set agendas. So, even if a citizen has some say in the outcome, she generally has little say over the types of issues, formulations of policies, etc. More importantly, very little effort is devoted to giving a voice to those most in need of voice.

It does not really matter what democratic theory the teledemocrat enthusiast assumes or promotes: pluralist, populist, communitarian, or some combination thereof (Abramson 1988). All currently invoked theories suffer from the same flaw-they refuse to promote the welfare of the disadvantaged. Failure to place the disadvanataged at center stage dooms almost every attempt to use technology as a means of enhancing democracy, since the powerful almost always gain at the expense of the powerless.

Pluralists, for example, see politics as mediating conflicts between competing interest groups, thereby promoting projects emphasizing dialogue among citizens. Populist want to capture the general will through plebiscites. Adherence to either of these versions of democracy dooms teledemocracy from the outset.

Neither pluralism nor populism devote a great deal of attention to unequal power relations among groups in society. Both versions accept the differential power relationships among groups as a given. The socio-economic status of these groups serve as a background which democratic theory does not directly address. Teledemocrats adopt these assumptions when they incorporate pluralism or populism into their conception of democracy.

Within the context of teledemocracy, pluralists promote dialogue and not plebiscite. To take one illustration, Congressman Edward Markey's Electure, sponsored by The Source of Participation Systems, Incorporated, allowed citizens to enter into a debate over arms control policy. Citizens did not have any control, to say nothing of influence, since Markey had announced his position well in advance of the experiment, over the policy, but a very select few had the privilege of taking part in a conversation with a well-known political figure over policy via a computer conference. The choice of those who participate in the dialogue does not positively depend upon a person's status with a lower socio-economic group.

Pluralists divide the political world into interest groups. However, certain groups, namely those found in the oppressed and dominated categories, get left out of the pluralists classification scheme. The poor, welfare recipients, the homeless, etc. do not fall into clearly discernible, well organized groups compared to the most advantaged people, who have little difficulty forming powerful interest groups. Technology projects that do not directly confront this problem will exacerbate the social stratification, thereby further undermining democracy.

While pluralism utilizes one way of skirting the problem of social stratification, populism employs another. Populism takes on a highly individualistic quality in the hand of teledemocrats. Citizens do not debate but rather voice preferences through their vote. The project MINERVA involved an electronic town meeting of two middle class housing projects in New York City. Despite some dialogue the important part of the project consisted in polling participants for their opinions on various issues. As Arterton notes, populist teledemocracy projects handicap the operation of interest groups in favor of tallying individual preferences. Like Rousseau populists of this persuasion want citizens to act as autonomous individuals unaffected by the molding influence of groups.

Neither pluralist nor populists give very much credence to particular groups, particularly those representative of the least advantaged. Teledemocrats run afoul when they unquestioningly adopt pluralism or populism without amalgamating these with a social theory of democracy.

Conclusion

The first standard to apply to any teledemocracy project is to ask whether or not implementing it make the least advantaged members of society better off. If democracy requires some degree of citizen participation, then we need to address the obstacles to participation faced by the disadvantaged. New developments in telecommunications may help to overcome social inequality, but probably more equitable distribution of lesser forms of technology and more direct forms of politics will have a greater effect. Technology may help replicate the Athenian assembly, which barred women and slaves, too well.

Bibliography

Abramson, Jeffrey B., Arterton, F. Christopher, Orren, Gary R. (1988) The Electronic Commonwealth. New York: Basic Books.

Arterton, F. Christopher (1987). Teledemocracy: Can Technology Protect Democracy? Newbury Park, California: Sage Publications.

Laudon, Kenneth. (1977). Communications Technology and Democratic Participation. New York: Praeger.

Sartori, Giovanni (1987). The Theory of Democracy Revisited. Part 1: The Contemporary Debate . Chatham, New Jersey: Chatham Publishers, Inc.

ENVIRONMENTAL/SCIENTIFIC KNOWLEDGE AND LOCUS OF CONTROL

JAMES P. HAMILTON
PENN STATE UNIVERSITY
PENN STATE MONT ALTO
17237

Introduction

Most of the scientists who have ever lived and worked live and work now. Scientific and technological knowledge increases so rapidly that it outstrips our ability to absorb it. Specialists in given fields have difficulty remaining current in their specific disciplines, let alone achieve any currency in other, even related areas. In the past, when technology was based almost exclusively in Newtonian physics, average citizens could develop a working knowledge of the technologies directly affecting their lives. They could maintain automobiles, tractors, furnaces, typewriters, and such with only a few basic skills and a little perseverance. It is now infinitely more difficult to do so.

We have benefitted greatly from this vast increase in scientific and technological knowledge over the past hundred years: medicine, transportation, and communication come to mind as prime examples. But, as in all things, a few negative aspects of the scientific and technological revolution have developed. One of these negative aspects has been a loss of control over everyday circumstances. The amount of scientific and technological data one needs to make intelligent choices has grown dramatically — and as the need for knowledge has grown, so the choices have grown more difficult to make. Renshon (1979) argues that:

> there is within each of us a need for considerable influence over the people, events and institutions that have a substantial impact on our well being and valued life pursuits. This need, which I have called the need for personal control, is suggested to arise out of the complex interplay between somatically based needs and socially based satisfaction. Furthermore, once acquired, this need gives rise, as conceptual development proceeds, to a series of basic assumptive beliefs about the nature of the world and its operations; among the most important of these are individual beliefs in personal control. (p. 41)

Several elements must be present if people are to keep control of their lives: First, they must have sufficient knowledge. Without knowledge, they cannot analyze the problems, perceive possible solutions, and/or make viable decisions. Second, they must realize that real choices exist. Knowledge without the possibility of genuine choice leads to little action and much frustration. Third, they must want to act. The desire to act derives, in part, from the belief that their choices will make a relevant and desirable impact.

Attribution theory research has long explored relationships between people's beliefs about their ability to influence the circumstances of their lives and the way these beliefs manifest themselves behaviorally. Whether people view their actions as producing or not producing results seems to affect their behavior. To investigate this relationship, Rotter (1966) developed an instrument to measure what he called "locus of control." He defined internal locus of control as that situation in which an individual feels that reinforcement follows and derives from his own action. Rotter defined external locus of control as that situation in which an individual feels that reinforcement does not result from his own action but rather from external factors such as luck or fate. Subsequent development of the locus-of-control construct has resulted in the identification of a number of characteristics.

One of these characteristics is multi-dimensionality. After considerable manipulation, three generally accepted dimensions to locus of control emerged: Personal Control, Social System Control, and Fate or Chance as defined by researchers such as Levenson (1973) and Reid and Ware (1974). The Personal Control dimension dealt with the extent to which individuals feel that they can exercise control over such personal behavior as smoking or eating. Social System Control concerned the extent to which individuals feel they can influence the educational, informational, social, political, technological, or economic systems which affect their lives. Fate or Chance concerned the extent to which individuals feel that such factors control their lives.

Another important attribute of locus of control is that it seems situational- or subject-specific. The majority of studies view locus of control as a general orientation of life circumstances. People see themselves either as generally in control of their lives or controlled by external factors. This view proved to have limitations, and the critical question became: "locus of control with regards to what?" A number, notably Lefcourt, VonBayer, Ware and Cox (1979) argued that "specific expectancies are assumed to be more powerful predictors of criteria related to those expectancies that are generalized expectancies" (p. 288) In other words, while few people may be generally internal or external in orientation no matter what the subject area or situation, many more will likely differ in orientation depending on circumstance. We should, therefore, examine locus of control within the context of a specific situation or knowledge area, such as scientific or technological literacy.

A final, important characteristic of locus of control is it changeability. Most of the early studies treated locus of control as a relatively stable personality trait. Subsequent investigations dropped this notion in favor of the assumption that locus of control could be changed, and Lefcourt (1976) concluded:

> Research with both naturally occurring and contrived events has revealed that locus of control scores assessed by scalar and/or behavioral means are susceptible to influence. People change in their customary causal attributions if they encounter experiences that meaningfully alter the contingencies between their acts and perceived outcomes (p. 126).

In summary, we understand locus of control as the extent to which people feel that they have some control over circumstances which affect them. Though some disagree, the dimensions of this control have generally been accepted to be Personal Control, Social System Control, and Fate or Chance. Perceived locus of control is often situationally bound and, therefore, not necessarily a general life orientation. Both as a generalized expectancy and as a situation expectancy, locus of control is not a constant; influences shape it. We also know that locus of control affects and is affected by a variety of variables. One of the most interesting of these variables is knowledge.

Knowledge and Locus of Control

Nearly all of the early studies examined the relationship between knowledge and locus of control by assuming that locus of control was the independent variable. Researchers such as Rychman and Sherman (1976) and Davis and Phares (1967) first tested their samples for locus of control with a generalized expectancy scale. They then looked at such things as academic performance, information-seeking behavior, or knowledge relevant to the individuals. The early conclusions centered around the notion that internals had more knowledge than externals and engaged in more and better information-seeking and that, somehow, locus of control caused these differences. This need not necessarily be so. If a causal relationship between knowledge and locus of control exists, it may well be that for many, increased knowledge moves them toward internality. This may be a chicken-or-egg question, as illustrated by Ramsey and Rickson (1976):

> There is a circularity between attitudes and knowledge in that one does not solely use or even precede the other, but rather some knowledge may lead to initial formation of attitudes which in turn lead to further gains in knowledge and so on (p. 13).

While the circularity problem may not prove entirely solvable, we can look at the relationship between knowledge and locus of control from a perspective somewhat different from the great body of early research. For the most part, internality is desirable, except in such necessarily strict behaviors as military procedures. Over the last several years, the Penn State Conservation Leadership Schools have explored ways of altering locus of control, with regard to environmental problem-solving, in the direction of internality. What follows reports and discusses those efforts.

Locus of Control and Environmental Knowledge

In 1982 and 1988, we undertook studies to determine if we could change the locus of control of a group of 15-17-years-old students in a very specific area of scientific, social, and technological knowledge: environmental problem-solving. In an interim study, Hamilton (1986) found a significant relationship between the general knowledge possessed by individuals and their environmental locus of control. We wanted to find out not only if we could make changes in predicted ways but also if the changes in students' feelings about their ability to help solve environmental problems would relate to changes in their combined knowledge of ecology, the agencies and organizations that manage and regulate the natural resource base, and environmentally appropriate technologies.

Procedures

1982 Study

Instrument development: Two instruments were designed. The first, a general-knowledge test, measured student's knowledge of ecology, environmental problems, and environmental regulatory agencies. The pre-tested final version had 48 multiple-choice items with a Kuder-Richardson reliability of .69. The exam had no particular breakdown into such subscales as ecological versus technological knowledge. The second was a locus-of-control instrument specific to the understanding and solving of environmental problems. Called the Environmental Attitude Scale (EAS), its pre-tested final form consisted of 30-forced-choice Likert-format items and had a Chronbach-Alpha reliability of .77.

Results: We used a simple pre-test/post-test control-group to see if exposure to the Conservation Leadership School curriculum had made any difference in environmental locus-of-control and knowledge. Ninety-eight usable question sets were completed and, in both cases, indicated a significant change. Table 1 illustrates the results:

Table 1

Locus of Control

	Score Mean	Difference	T-Value	Significance
Time 1	91.47	7.02	5.58	0.000
Time 2	98.50			

Environmental Knowledge

	Score Mean	Difference	T-Value	Significance
Time 1	20.30	3.62	6.95	0.000
Time 2	23.92			

No difference was observed between the post-test scores of the students who took the pre-test and the control group. Subsequent regression analysis found no relationship between the amount of change in locus of control and the amount of change in environmental knowledge.

1988 Study

Instrument development: We used the same basic format for the 1988 study. However, the instrumentation and analysis differed. The Environmental Knowledge Test contained only 31 multiple-choice items falling into two areas: ecological/technological knowledge and knowledge of the agencies and organizations who manage and regulate the natural resource base, which we called regulatory knowledge. The Kuder Richardson reliability was .42.

The EAS had only 17 forced-choice Likert-format items in order to reduce the administering time. The Chronbach-Alpha was .78.

Results: The same pre-test /post-test control group design (with the post-test given at the end of the CLS program) produced 79 usable sets of questionnaires. The change in environmental knowledge and environmental locus of control approximated the 1982 results, significant at .001. And again, there was no significant difference between the control group (post-test only) and the others. At the end of the CLS, students had more environmental knowledge generally and greater belief they could make a difference in helping to solve environmental problems than they had when they began the program. In addition, a regression analysis between the change in the amount of knowledge and the change in locus of control found no significant relationship between change-in-total-knowledge score and change in locus-of-control score. Neither was there a significant relationship between change in ecological/technological knowledge and change in locus of control. However, there did seem to be a relationship between changes in regulatory knowledge and change in locus of control. Table 2 illustrates the results.

Table 2

Environmental Knowledge

	Score Mean	Difference	T-Value	Significance
Time 1	15.32	3.83	11.21	0.000
Time 2	19.15			

Locus of Control

	Score Mean	Difference	T-Value	Significance
Time 1	51.81	4.97	6.22	0.000
Time 2	56.78			

Ecological Knowledge

	Score Mean	Difference	T-Value	Significance
Time 1	7.74	2.05	8.95	0.000
Time 2	9.79			

Regulatory Knowledge

	Score Mean	Difference	T-Value	Significance
Time 1	7.52	1.84	6.98	0.000
Time 2	9.36			

Regression Analysis

	Correlation	R-Squared	Significance
Overall knowledge vs. LOC	.1795	.0322	.14
Fco./knowledge vs. LOC	.0335	.0011	.78
Reg./knowledge vs. LOC	.2436	.0594	.04

Discussion

The relationship between knowledge (either general as measured by academic performance or specific to a subject area) and general locus of control was well established before we undertook these studies. A relationship also appears between the amount of general environmental knowledge and environmental locus of control. We confirmed the notion that locus of control, at least within a given subject area, could be changed in a predictable direction. Students completing the Conservation Leadership School curriculum were more internal regarding environmental locus of control than they were before they began the program. They also had significantly more knowledge of both ecology and the regulatory mechanisms of the natural resource base after finishing the program. The results also demonstrated that a locus-of-control instrument specific to a fairly narrow area of scientific and technological knowledge could be developed with acceptable reliabilities.

However, the expected relationship between change in general environmental knowledge and environmental locus of control was not supported. The most interesting aspect of the study was that while increased knowledge of ecology did not relate to changes in environmental locus of control, increased knowledge of the agencies and organizations which manage and regulate the natural resources of the state (and, in some cases, of the world) did relate. While not a strong relationship, significant at the .05 level, it is enough to intrigue.

Though further study is certainly warranted before any firm conclusions can be drawn, we might postulate a few explanations. Knowledge of how things are regulated is, by extension, knowledge of where to go to make an impact on that regulation. Many environmental problems, when understood, are recognized as the result of the cumulative behaviors of millions of people. Specific scientific knowledge about these problems can only realistically be put to use by the individual and the few he can influence. Unless the individual can be powerfully convincing, his efforts are likely to fail or to produce insignificant results, even at the local level. If, however, the regulatory agencies can be influenced, the result may well become significant on the national level. Thus, understanding the regulatory process generates a greater sense of empowerment than simply understanding the ecology. Further research across a broader spectrum of science and technology must be done before the distinction between different kinds of knowledge and their impact on locus of control is fully understood.

These studies fell into a very narrow area of scientific and technological knowledge. We must take care not to generalize beyond the conditions of the studies. Other areas lack the regulation that marks environmental concerns. However, the great body of research into locus of control shows clearly a relationship between knowledge and locus of control. Whatever the measuring methodology, the relationship appears.

The relationship may be circular, but we believe that the process most often begins with knowledge. The implications are not very appealing. Scientific/technological illiterates will necessarily lack internal locus of control in those matters. Externals will less likely participate in matters over which they feel little control (in this case, scientific and technological matters). They divorce themselves from decision-making processes that derive from and are influenced by science and technology — an integral and growing part of modern society. These decisions, made by a well informed but relatively small elite, cannot be truly representative.

References

Davis, W. L., & Phares, E.J. (1967). Internal-external control as a determinant of information-seeking in a social influence situation. Journal of Personality, 35, 547-561.

Hamilton, J.P. (1986). Environmental locus of control as a function of the perceived importance of environmental problems and environmental knowledge. Journal of Interpretation, 11, (2), 15-31.

Lefcourt, H.M. (1976). Locus of control: Current Trends in theory and research. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Lefcourt, H.M., VonBayer, C.L., Ware, E.E., & Cox, D.J. (1979). The multidimensionality-multiattributional causality scale: The development of a goal specific locus of control scale. Canadian Journal of Behavioral Science, 11, 286-304.

Levenson, H. (1973). Multidimensional locus of control in psychiatric patients. Journal of Consulting and Clinical Psychology, 41, 397-404.

Ramsey, C. E., & Rickson, R.E. (1976). Environmental knowledge and attitudes. Journal of Environmental Education, 8, 264-271.

Reid, D.W., & Ware, E.E. (1974). Multidimensionality of internal versus external control; Addition of a third dimension and non-distinction of self versus others. Canadian Journal of Behavioral Science, 6, 131-142.

LANGUAGE AS FULCRUM
IN SCIENCE AND HUMANITIES

Stephen Tchudi
Department of English (098)
University of Nevada
Reno, Nevada 89557
(702) 829-7195

Language -- both the written and spoken word -- has long been problematic for learning and scholarship in science and the humanities. Language is unavoidable as a medium of communication, yet it is slippery and difficult to control. Writers and speakers find it frustrating, even painful, to discover the words needed to express their ideas, and language based misunderstandings are legion, legendary, and often disastrous.

In his study of The Artificial Language Movement, Andrew Large (1986) presents some fascinating insights into the views of language held by scientists during the early era of modern science. He notes that in the seventeenth century, as England's Royal Society was formulating ground rules and procedures for scientific investigation, its members were concerned about problems induced by language. Some doubted that natural languages (e.g., English, French) could adequately serve the scientific community. Natural languages were ambiguous and vague in their vocabulary and lacked the precision of scientific formulae. Many scientists felt their field should have a universal vocabulary to prevent misunderstandings; some even believed that scientific discussions should be conducted in a common or universal language to eliminate translation problems.

Large notes that as early as 1636 René Descartes had discussed the notion of "philosophical" or artificial languages to serve both philosophy and science. A first major effort at creating such a language appeared in 1668, with the publication of John Wilkins' An essay toward a real character and a philosophical language. Wilkins, a Scottish cleric, was also an astronomer, mathematician, anatomist, agronomist, biologist, physicist, and cryptographer. (Why shouldn't he be a linguist as well?)

Wilkins concluded that his artificial language would require approximately eight thousand symbols to name the objects and phenomena of the known world. Since William Shakespeare had already employed about 30,000 words in the plays and sonnets, one can see that Wilkins' artificial language would allow for a considerable, possibly naive, reduction in vocabulary, presumably by eliminating synonyms and imprecise or even "poetic" words. (Or, he may simply have had a limited view of how much raw material there was in the world.)

In designing his vocabulary and phonetic system, Wilkins speculated:

> " . . . if the Names of things could be so ordered, as to contain such a kind of affinity or opposition in their letters and sounds, as might be some what

> answerable to the nature of the things which they signified; This would be yet a farther advantage superadded: by which, besides the best way of helping the Memory by natural Method, the Understanding likewise would be highly improved; and we should, by learning the Character and the Names of things, be instructed likewise in their Natures, the knowledg of both of which ought to be conjoyned."

That is, Wilkins sought a language in which the words themselves described exactly the object which they named. Further, he wanted a phonetic language -- easily memorized -- with a dual correspondence: one between the letter or phonetic symbol and its pronunciation, a second between the symbol and its real-world correlative.

Perhaps the closest analogy I can make to this clever scheme is to have you imagine a library call number which, through its digits, would tell you not only how to pronounce a word, but what the word meant as well, that word also functioning as a summary or index of the book's content. In Wilkins' language there could be no slip twixt eye, tongue, and meaning.

To accomplish this scheme, Wilkins created a forty unit taxonomy. Each genus was assigned a consonant and vowel; differentia were expressed by an additional consonant; and species were represented by additional vowels or diphthongs. Grammatical relationships -- active and passive, for example -- were indicated by hooks and loops attached to the letters.

Wilkins succeeded in creating the language, and his Essay included a translation of The Lord's Prayer to show that the "universal character" could even handle abstract and philosophical concepts. Royal Society member Robert Hooke later wrote an essay on timepieces in this language and found it "free from all manner of ambiguity." Yet, Wilkins' "universal character" was never adopted by the Royal Society, and it never became widely used in scientific efforts.

In the three hundred years since Wilkins wrote, there have been other efforts to create artificial languages for science and philosophy that would have the traits of absolute clarity and precision, yet none of these has become established in the scientific community.

Perhaps the most successful of the artificial language experiments has been Esperanto, created by a Polish ophthalmologist L. L. Zamenhof in 1887. The Esperanto movement presently claims seven to twelve million speakers/users worldwide, and its various organizations include several science interest groups that publish journals and conduct conferences in Esperanto. Esperanto soves some problems identified by Wilkins, including phonetic regularity and universal vocabulary. (Richards, 1988) However, it is structured similarly to a natural (Indo-European) language, and like all such languages, lacks the formulaic precision of Wilkins' universal character. Further, despite its success, Esperanto has been eclipsed by at least one language, English, in its aim of becoming a worldwide second language. (McCrum, Cran, and MacNeil, 1986)

Given the felt need for a more precise, unambiguous language for science, one has to wonder why none has emerged or established itself as a standard.

To answer that question, we need to recognize that among the slippery traits of real or natural language is its unwillingness to submit to external rules and laws. The classic failure of the French Academy to exclude Americanisms from French -- _le hotdog_, for instance -- shows that languages, or rather, the people who use them, set their own rules and traditions through popular usage.

As attractive as it might seem, a purely logical artificial language fails to respond to a great many communications needs, including the very ambiguity and imprecision it is designed to eliminate. In science, for example, an artificial language such as Wilkins' might be superb for presenting routine laboratory findings, but might not allow the researcher to delve into subtlety, nuance, and speculation. It could possibly work well for the Newtonian world in which Wilkins lived, but it would likely fail in post-Newtonian study. In fact, a purely logical language might eliminate or make difficult many of the discussions of values, implications, possibilities which are so central to the STS movement.

More important, the vision of a perfect or flawless language is itself naive and flawed. One can no more imagine a "pure" language of denotation than one can imagine "pure thought," with ideas somehow disentangled from human experience, perception, or even biological/neurological functions. In the twentieth century, post-Newtonian linguistics has helped us see that language (like thinking), is inextricably bound up with human affairs.

Nor, to put it bluntly, is human thinking so simpleminded as to be translated into an idealized language. When we debate propositions in science and the humanities, we weigh probabilities, possibilities, and intangibles. We don't paste concepts together with syllogistic simplicity. Platonic logic (another idealized system) allows one to combine a major and minor premise to conclude that Fido, a dog, has fleas, like all dogs. But in real life, we're more likely to observe Fido scratching, find out where he's been, experiment with flea powders, and talk with a vet. Our logic, like our language, has some ad hoc characteristics.

Although most scholars and teachers are quick to acknowledge the complexity and ambiguity of contemporary thinking and language, their understanding is not always reflected in the classroom. Too often teachers act as if real languages are, in fact, Wilkensian perfect languages. Teachers ignore the semantic problems inherent in language or curse the English/language arts faculty for its failure to teach grammar and spelling.

When we discuss technological literacy, for example, we should not make the mistake of thinking that "literacy" is nothing more than manipulative competence, skill at negotiating formulae or using lab equipment or computers. Computer literacy must include the real language that surrounds processes and operations, not simply the ability to spin out programs or apply them to new settings. Scientific literacy must include the ability to read and write critically and carefully, to frame and debate propositions, not simply to punch one's calculator to find a competent answer.

The metaphor in my title is that of language as fulcrum for interdisciplinary studies. Rather than acting as if language is neutral or invisible, teachers and scholars can perceive of it as a support, a pivot point, or hinge on which thinking and learning are based. By focusing on language-as-fulcrum teachers can insure the fullest possible literacy of their students in science and the humanities.

I will briefly present three concepts which have emerged from linguistics and will suggest how teachers can employ them, day by day, to help their students become more literate learners:

1) Grammar is an inexact science. Many of us were raised in schools where grammar was taught as law. There were rights and wrongs which the schoolteacher enforced, and woe be unto the child who said "ain't" (even if that child's mom, dad, uncles, aunts, and playmates used "ain't" quite naturally). Although the regularites of English syntax can

be charted with considerable accuracy to create a formal grammar, we recognize that "practical grammar" (or "language in action") cannot be separated from context or meaning. Human beings are remarkably creative in experimenting with grammar to get their ideas across. Both scientists and kindergartners, for example, use metaphors freely when conventional words and syntax fail them.

Wilkins' contemporary, John Locke, recognized in his _Essay Concerning Human Understanding_ (1690) that there is an "imperfect" relation between words and "the things they are supposed to represent," and he warned that words should not be allowed "to stand also for the reality of things."

Contemporary semantics describes that imperfect relationship in three sentences:

> "The word is not the thing."
> "The map is not the territory."
> "The symbol is not the thing symbolized."
> (Hayakawa, 1990)

In the classroom, we can help students explore the relationships between symbols and perceived reality, warning them _not_ to accept anything written or spoken as _ipso facto_ "true," not to assume that what they mean by a word is what others will take that word to mean. Although some scientific and mathematical terms have one-to-one correspondences with their referents (e.g., _hypotenuse_, _helium_), much of our language is awash in ambiguity.

Teachers can also help students think about the complexities of meaning in propositions and assertions. Compare, for example, the following two sentences:

"Might makes right."

"Respiration makes carbon dioxide."

With the exception of "carbon dioxide," which "equals" or spells out a formula, CO_2, every word in those sentences has some ambiguity. Further, although the sentences have parallel syntax (subject-predicate-object), their "real" or "practical grammar" structures differ dramatically. The first is a value proposition, while the second is a statement of a scientific observation. In particular, the word "makes," serving identical syntactic functions in both sentences, clearly has different meanings in each one.

I don't propose that teachers debate each word in each sentence in every science or humanities class, but it is important that we remind students of the fluidity of "practical grammar." It is vital for us to question the surface meaning of sentences, to discuss the origins of terms and definitions, to look at "waffle" or qualifying words in statements. We should not only ask, "What does this mean?" but also "How does it mean?" In this way we can help students move away from passive acceptance of textbook truisms toward critical analysis of language and meaning.

As a simple example: In my interdisciplinary classes for prospective teachers of math, science, English, and social studies, I ask my students to "prove" the truth of the widely held belief that "The earth is round." I have learned (among other things), that the earth is not strictly "round," but I have been concerned to observe that whether discussing a perfect or flattened sphere, many students have based their knowledge on what I would call "hearsay" evidence: "It's in the book." "I learned that in grade school." Good students are often hard pressed to phrase their proofs of earthly roundness in language. For example, I have heard stories of ship masts that disappear over the horizon seventeen miles out from shore as proof that the earth curves, an example which could just as easily substantiate the worries of Columbus' crew! This exercise is more than mere semantics, of course. It employs language as a fulcrum to get at what seems to me a more fundamental question, "Why should we accept without questioning the truths which texts and teachers give us?"

2) Language and thinking are inseparable. This statement is precisely one of those truths which needs to be investigated, not just recited. Of course we know that "You don't understand a thing until you say it" or that "You often figure out what you're going to say just as you are saying it." However, the relationship between language and thinking is far more complex than is suggested by that old metaphor of "dressing your ideas in words" just before you show off your intellectual finery in public.

Modern linguistics has demonstrated that language systems powerfully affect how we perceive the world. Language sets parameters on our classifying systems. How we "see" the world depends in no small measure on the vocabulary we use to record our observations. Of course, we are free to change those systems and vocabularies to accommodate new ideas, but old languages, like old paradigms, exert long lasting influence on our thinking. We also know that a great portion of our thinking is verbal as well as symbolic and visual, that we don't think abstract and disembodied "thoughts" and are constantly framing verbal propositions in our minds.

Teachers and the public are quite properly concerned about the surface structure of students' language: good usage and mechanics, proper spelling. But concern for language must go deeper. Spelling and grammar lessons are trivial in comparison to helping students think critically and imaginatively through language.

One useful way to use language as a fulcrum for critical thinking is the classroom journal, where students note their reactions to the material being presented. Some teachers use a "split column" journal where students write down "the facts" to be learned on one side of the page and their puzzlements on the other. Good questions which students raise include: "What's the proof?" "How do we know?" and "So what?"

In the elementary grades (and to a lesser extent in secondary grades and colleges), teachers use imaginative language activities as a fulcrum for enriched understanding. "Write a journal entry from the perspective of one of the crewmen sailing with Columbus. Would you have believed his argument that the world is round?" Or, "Imagine that you are Columbus and you realize that your ship hasn't reached your goal of circumnavigating the world. What does this do to your theory of the world?"

Using language as fulcrum can be as simple as discarding the stock problems and study questions posed in the textbook and either writing your own or having students create some. Over time teachers can establish a collection of original problems for use with the next class. Such an activity not only creates problems which offer more imaginative challenges than those of the book, it also forces instructor and students to blend their disciplinary understanding and their language in fresh and imaginative ways.

3) Language grows to accommodate experience. There is a misleading pedagogy implicit in John Wilkins' perfect language scheme. The "universal character" suggests that knowledge and learning consist of the naming of parts, rather than discovery and inquiry. Knowledge is created by linking one known entity, clearly defined and properly spelled, to another, through mathematically precise syntax.

Although Wilkins' language is dead, a similar view of knowledge and learning is anything but dead in many school and college classrooms. In Wilkins' day and our own, mastery of vocabulary or terminology is frequently substituted for in-depth, heart-felt understanding of the subject itself. As a result, it is a common complaint that even if students have come to "know" history or literature or math or science, they don't apply it in their own lives. What they have mastered, of course, is a hollow language of recitation. It's little wonder they don't transfer key concepts to their lives.

One of the most important intellectual discoveries of the twentieth century is that knowledge is uncertain, relative, tentative, and speculative. There are few sure bets in the knowledge game. And contemporary linguistics has shown us that language reflects and embodies that uncertainty.

Language grows in and through the process of learning. We don't master a language first and then fill our heads with concepts; we acquire both concurrently. This phenomenon is perhaps most evident in the language acquisition of babies, who learn the complexities of language "on the job." The same mechanism operates for older learners as well. As we encounter new situations and problems, our language repertoire grows to allow us to discuss our perceptions and discoveries.

It is here that language can most successfully serve as a fulcrum for improved learning in science and humanities. As I see it, STS pedagogy is discovery-oriented and issue-centered. It invites students to pose questions and to seek answers for themselves. STS is an ideal proving ground for language skills, because language is mastered through the same process. As students use words to explore their worlds and to discuss and verify their findings, they grow as language users and critical thinkers. Discovery through language thus serves two purposes: It helps students develop an understanding of their world even as it expands their control of language itself.

In school and college classes, for example, I use a language-centered interdisciplinary heuristic I call "The Quest." With language as a fulcrum, students (singly or in groups) identify topics they want to explore from an interdisciplinary perspective, list questions they want to answer, describe their present knowledge, identify information sources, design research projects, collect data, and work their findings into a multimedia presentation. Their use of language is considerable: They read, write, talk, and listen. They inquire and debate. They explain. In these STS-style projects students read a wider range of materials than they would ordinarily: books, magazines, journals, and brochures, not just texts. In using language to formulate their ideas and findings, students also come to understand the imperfections and slipperiness of language, even as they exploit its extraordinary flexibility in letting them say what they have to say.

There are many other ways in which teachers can link students' personal growth, their mastery of the (inter)discipline, and their skill in language. For example, teachers can:

-- supplement or even replace the conventional textbook with good library or trade nonfiction books, in particular books written for young readers. Where textbooks tend to give students summary or capsule statements of key concepts, good nonfiction often lets students come to understand the processes and procedures of a field or discipline.

-- have students examine STS issues in daily newspapers, in particular, examining the ways in which newspaper language frequently oversimplifies or dramatizes research results or presents an image of science as magic.

-- find real world audiences for students' writing and projects. Instead of conventional tests and papers, teachers can let students write letters to editors, to scientific and cultural agencies, to university researchers.

-- set up an STS Soapbox, where students can, from time to time, speak up or write out on issues that deeply concern or move them.

-- use electronic media as forms of composition, having students create slide shows, videos, computer simulations and displays, all of which draw on and enhance language skills.

Teachers of science and humanities are busy people, with a hefty curriculum to cover, and it's difficult to find time for "extras." I hope my examples in this essay have demonstrated that using language as a fulcrum is not yet another extra, but something that can be integrated into teaching every day. No doubt many STS teachers are already doing a great deal of language awareness work already. In any case, I hope it is clear that teachers of science and humanities can't afford to ignore language or to act as if it is invisible. By integrating language awareness across the curriculum, teachers in all fields can not only solidify their students' learning, but help those students in their quest to master the universal medium of language.

References

Hayakawa, S. I., & Alan Hayakawa. (1990) _Language in Thought and Action_, 5e. Orlando, Florida: Harcourt Brace Jovanovich.

Large, Andrew. (1986). _The Artificial Language Movement_. London: Basil Blackwell.

Locke, John. (1690). _An Essay Concerning Human Understanding_.

McCrum, Robert, William Cran, and Robert MacNeil. (1986). _The Story of Language_. New York: Penguin.

Richardson, David. (1988). _Esperanto: Learning and Using the International Language_. Eastsound, WA: Orcas.

BROADENING THE SCOPE OF ENGINEERING ETHICS:

FROM MICRO-ETHICS TO MACRO-ETHICS

by

Robert Hudspith

Faculty of Engineering
McMaster University
Hamilton, Ontario
L8S 4L7

I INTRODUCTION

Many engineers believe that their responsibility to society in the 'doing' and controlling of technology can be approached through a consideration of ethics. This notion is so firmly embedded in the culture of the profession that the two terms 'social responsibility' and 'ethics' are considered synonymous. Courses that attempt to deal with the larger issues of technology and society are often referred to by students as ethics courses (usually by those who haven't taken such courses). Many in the STS community would argue that this approach to social responsibility is too narrow and unduly restricts the scope of what should be considered. Instead of trying to change this approach, however, perhaps we can broaden the scope of what has traditionally been called ethics by making a distinction between 'micro-ethics' (that which is usually covered by codes of ethics) and 'macro-ethics' (that which concerns larger questions about the nature of technology, the nature of design, and the nature of being a professional). Before discussing what this broadening might include and involve, it would be worth considering briefly how the engineers' concern for social responsibility developed and came to be seen through the door of ethics.

II SOCIAL RESPONSIBILITY AND ETHICS

The concern for social responsibility does not have a long history in engineering. Most of the earliest engineers were military engineers whose main responsibility was obedience to the military establishment. In times of peace the responsibility was shifted to obedience to the state with most of this civil(ian) engineering work being public works such as water supply, sanitation, roads, and public buildings. As other branches of engineering developed, such as mechanical and electrical, engineers were under the authority of commercial enterprises. It was not until the late nineteenth and early twentieth centuries that a strong engineering movement, concerned with their responsibility to society, arose. Many began to argue that technology was so important to society that the primary responsibility of the engineer should be to the public and not to their employer (Mitcham, 1987; Layton, 1971).

Acknowledging the social importance of engineering work, engineers established societies, not only to advance technical knowledge, but to set standards, and establish a code of ethics. In Ontario, the need to regulate the practice of engineering in the public's interest resulted in the Association of Professional Engineers of Ontario being established as a self-regulating profession by law in 1922. The primary mechanism within this legislation for ensuring responsible conduct within the profession was seen to be the establishment and enforcement of a code of ethics. This ethics approach to questions of social responsibility continues to be a focus in the profession and in engineering education.

Engineering ethics textbooks perpetuate this approach to social responsibility. Unger, in his book Controlling Technology: Ethics and the Responsible Engineers (1982), argues that, in addition to better education concerning ethical issues, we need better ways to support individual engineers in their attempts to be ethical. Martin and Schinzinger in their text Ethics in Engineering (1983), also argue for the centrality of ethics but try to broaden the scope by suggesting that we need a different philosophy of engineering, one that considers each engineering project as a social experiment. This opens the discussion to a consideration of the ethics of experimentation.

The analysis of recent engineering failures, from both the profession itself and the public, has further reinforced this ethics framework for understanding technological responsibility. Whenever there is a major technical disaster, such as Bophal or the Challenger, there is an assumption that there has been a moral failure, i.e., someone has acted unethically. This concern about moral judgement, however, may address only one part of the problem; perhaps the present scope of ethics does not address many of the larger and more underlying issues that could be at stake. The Challenger disaster will be used to illustrate this point.

The traditional ethics approach to what went wrong with the Challenger leads to questions concerning the conduct of Boisjoly and Thompson, engineers at Morton Thoikel, and the engineer-managers who recommended a launch in spite of the dangers. While it is true that micro-ethical issues were important, we would miss some important lessons about the nature of technology and the broader issues of technology in society if we were to stop our analysis there.

A closer look at the events and problems surrounding the accident indicate that there were many failures. The complex systems nature of the technology involved, which includes not only complex hardware, but a wide range of persons and groups in the larger socio-political context, has a tendency to fail in unanticipated ways. As engineers we need to appreciate these multiple failure characteristics of complex technologies. In the case of the Challenger, there were problems with environmental factors, design/hardware failures, production pressures, troubling political involvements, and problems with the decision to launch procedure. Furthermore, a fuller consideration of this accident would have to include an analysis of the nature of expert decision making and the limitations that it has on issues of control (Hudspith, 1988).

The remainder of this paper will explore in more detail the scope of micro-ethics as they are expressed in codes of ethics and the suggested scope of what could be called macro-ethics. The paper will conclude with some suggestions on how this broadening of the scope of ethics can be implemented.

III MICRO-ETHICS: THE PRESENT SCOPE, APPLICATION AND LIMITATION OF THE CODE OF ETHICS

A typical code of ethics addresses a practitioner's duty to act with "fairness and loyalty to his or her associates, employers, clients, subordinates and employees; fidelity to public needs; and devotion to high ideals of personal honour and professional integrity" (A.P.E.O., Sec. 91.1, 1984). Furthermore, the engineer is reminded to "regard his or her duty to public welfare as paramount" (A.P.E.O., Sec. 91.2, 1984). The remainder of the code (and in Ontario's case, the regulations on professional misconduct (A.P.E.O., Sec. 86, 1984)) gives these general statements more specific meaning by highlighting such things as: safeguarding the life, health, and property of persons affected by the work; following other codes and by-laws; maintaining competence; avoiding conflict of interest; regarding certain matters as confidential; respecting and supporting other engineers; and maintaining the public image of the profession. One of the chief characteristics of all of these principles is that they are meant to apply to the conduct of individuals in specific situations that arise in the day-to-day practice of engineering. It is this individual and specific focus that characterizes these as micro-ethics.

Some of the debate concerning the value and role of the code focuses on the issue of enforcement vs. guidance (Mucklestone, 1990). Those who argue that the code should be for disciplinary purposes would prefer to see the use of more legal language in the codes. Others argue that the focus of 'doing no harm' misses the main point concerning the purpose of the profession, that is, to make a positive contribution to human welfare. Here the main purpose of the code is seen as guidance for proper moral conduct. Both sides of this debate appeal to the conscience, implying that the ethical issues are moral issues; one side warns against wrong conduct while the other side seeks to encourage right conduct.

This focus on individual conduct and moral reasoning does not seem to be as central when it comes to other aspects of an engineer's concern for social responsibility. If we are to use the term 'macro-ethics' to characterize these other issues we will also require a different focus. A brief overview of the scope of macro-ethics will illustrate this point.

IV THE SCOPE OF MACRO-ETHICS

Without attempting to be exhaustive, we could group the types of macro-ethical issues that are important to the practice of engineering into three categories.

The issues to be considered in each category can be illustrated by questions.

1. The Nature and Structure of Technology

> What are the built-in characteristics of particular technologies? How do these characteristics affect or determine how a technology is to be used? Is the systematized nature of technology today necessary and inevitable? How do these built-in characteristics reflect the values of a culture?

2. The Nature of Design

> How has the process of design changed in the past few centuries? Are all problems open to solution by the design process? How does, and how should, the role of the designer in society change?

3. The Nature of Being a Professional

> What are the strengths and limitations of being an expert, a specialist, a professional? Are concerns of the public due to misconceptions or is there a non-expert social rationality that sees problems differently? How does our professional education shape the way we think and practice? How should decisions concerning the implementation of new technologies be made?

While these questions only hint at some of the larger questions, they do illustrate that the focus of macro-ethics would be different from that of micro-ethics. The questions and issues relate primarily to the whole profession and our responsibility as a group. While they obviously have a bearing on an individual's practice, they are not something that would usually come under consideration in a practitioner's day-to-day work. Neither are these questions primarily moral issues; rather, they address concerns at the cultural level, reflecting what we believe about life and the role of technology in life. We live in a technicized culture, and as the doers and managers of what is called technology we have a special responsibility not only to include in our practice a consideration for our micro-ethical responsibility but to find ways to broaden our consideration for the broader macro-ethical issues.

V BROADENING THE SCOPE

The following suggestions are meant to be a starting point.

A. Changing Existing Codes of Ethics

While most codes of ethics deal only with what has been labelled here as micro-ethics, Unger suggests a few non-usual provisions that aim at macro-ethical concerns. Consider the following examples from Unger's Model Ethics Code:

1.1 Inform themselves and others, as appropriate, of the consequences, direct *and indirect* immediate *and remote*, of projects they are involved in

1.2 Endeavour to direct their professional skills toward conscientiously chosen ends they deem, on balance, *to be of positive value to humanity*:....

1.4 Help to inform the public about technological developments, the *alternatives* they make feasible and *possible associated problems*

2.1 Keep their professional skills up to date and be *aware of current events* and *societal issues* pertinent to their work (italics added) (Unger, 1982: 163)

All of these provisions would require asking questions that are outside of the usual scope of engineering work. They would profit in a significant way by a communal consideration by the profession. In the end, the individual will need to act one way or another, but the questions usually need a larger forum for consideration than one's own experience.

Examples of other provisions that would hint at macro-ethical issues are:

1. Openly recognize when alternative technical solutions are a reflection of different cultural beliefs and as such cannot be judged on the same basis.

2. Recognize that criteria are not easily quantified, but nevertheless should be included in the design process and should be given due consideration.

3. Make an effort to include in the design process all parties affected by a technical change.

While these may be too vague for guidance in specific cases, they do serve to remind a practitioner of the need to think about the macro-level.

B. The Structure and Activities of the Profession

As pointed out in the previous section, one characteristic of macro-ethical issues is that they refer to the responsibility of the profession as a whole. Perhaps the different professional societies and licensing organizations should endeavour to write a special code, a code that is meant for the profession and not the practitioner. Such a code would guide them in their setting of policy, standards, and guidelines for the practice of individual members. The existence of such a code would be an incentive to keep the questioning and probing both open and on-going.

Topical forums sponsored by the professional association would provide a mechanism for engineers to collectively consider the macro-ethical issues that face a particular group of engineers in a particular context. While such forums may not be able to come to a definitive answer they would provide a resource for individual practitioners as they are required to think through the issues and act upon them. A current example of this is the need for the Province of Ontario to sponsor forums to discuss the concept of sustainable development in the Ontario context, especially how it would affect the work of different branches of engineering.

C. Education

Most engineering schools continue to perpetuate the link between social responsibility and ethics. Unfortunately, the usual discussion about ethics revolves around the code of ethics and its application. As pointed out above, this restricts the consideration of responsibility to micro-ethical issues. By introducing a distinction between micro- and macro-ethics one could continue to use the familiar language of ethics while opening up the discussion and the curriculum to a broader and more fundamental set of issues.

Schools use varying approaches to expose their students to a consideration of technology and society. The range of topics, issues, and courses is extensive. Making clear throughout these courses the distinction between micro- and macro-ethical concerns will help students avoid trying to reduce all issues to micro-ethics or to dismiss the larger question as *merely* philosophical and outside their responsibility.

This approach to social responsibility recognizes that engineers use the door of ethics. Hopefully this door can be broadened so that certain avenues will not be missed.

REFERENCES

Association of Professional Engineers of Ontario (1984). Regulation 538/84.

Hudspith, R.C. (1988). Lessons from the Space Shuttle Challenger Accident, IEEE Hamilton Section Newsletter, April, pp. 7-12.

Layton, E. (1971). The Revolt of the Engineers. Cleveland: Press of Case Western Reserve University.

Martin, M.W., & Schinzinger, R. (1983). Ethics in Engineering. McGraw-Hill.

Mitcham, C. (1987). Responsibility and Technology: The Expanding Relationship. In P.T. Durbin (Ed.), Technology and Responsibility, (pp. 3-39). D. Reidel.

Mucklestone, C. (1990). Engineers and Ethics: A Matter of Conscience. Engineering Dimensions, 11(4), 30-31, 52.

Unger, S.H. (1982). Controlling Technology: Ethics and the Responsible Engineer. Holt, Rinehart and Winston.

Education from Kindergarten through Post-Secondary and Beyond

CHANGING THE FOCUS: FOSTERING THE DEVELOPMENT of SCIENCE, TECHNOLOGY and SOCIETY PROGRAMS in SCHOOLS

William F. McComas

Susan M. Blunck

Julia M. McArthur

The University of Iowa
Science Education Center
Iowa City, IA 52242

Mark A. Brockmeyer

Iowa City High School
Iowa City, IA 52240

Introduction

This paper deals with the challenging, stressful, dynamic, sometimes frustrating, but ultimately rewarding process of educational change. We will specifically address the change in focus from a traditional school-designed, fact-oriented science curriculum to a Science, Technology and Society (S/T/S) plan for science instruction in which students take an active role in delineating what is discussed in classes based on issues important to them.

Our discussion will draw upon two major resources to help convey the promises and pitfalls of the change process seen in schools moving from a traditional orientation to one featuring an S/T/S, issue-based, relevance approach. These two sources include the growing literature base addressing education change and the combined experience of a team of inservice workshop designers who, over the past few years, have helped several hundred teachers and administrators make the shift to S/T/S. The insights provided by those who have worked in inservice programs are useful in pointing out changes necessary to foster the development of a S/T/S orientation.

We agree with Goodlad (1984) who, following a study of the nations' schools, said that educational improvement "requires that we focus on entire schools, not just teachers or principals or curricula or organization or school-community relations . . ." Our experience supports this view. Only by insuring that all those who will be influenced by the proposed change understand its theoretical basis and practical application can any reform effort be effective. All too frequently, one or more of the key interested parties is left out of the process. By omitting them, the innovation is almost certainly doomed to fail.

Unlike some S/T/S proposals focusing solely on the curriculum, we are discussing the plan pioneered by the Science Education Center at the University of Iowa. This plan, with its' dual pedagogy and curriculum components was recently supported by the new National Science Teachers Association (NSTA, 1990) position statement on S/T/S education. The curriculum ingredient is still centered on instruction based on issues linking science with technology and society, as in all S/T/S schemes. It is the pedagogical change that represents the greatest departure from standard S/T/S education. In this new strategy, teachers are asked to adopt a new teaching strategy in which the textbook becomes a resource rather than the sole source for all science study with teachers themselves in a supportive not directive role. Teachers should encourage student questions and permit these questions to become the organizing force for classroom discussion. These changes in curriculum orientation and teaching style represent fundamental departures from the way many educators and school districts presently design and implement educational programs. These changes are essential if S/T/S is to have maximum effect.

This document is not a "how to" manual, but represents a starting place. Our intention to make our readers forewarned and forearmed in terms of the S/T/S-related change process as that process impacts teachers, students, administrators, parents and the community. The insights shared here are garnered from many years as workshop organizers and presenters. We thank the numerous inservice participants who have added to our understanding of the change process relating to science, technology and society education.

An Introduction to the Process of Educational Nature

The reality that *change is a process not an event* is lost on those who believe that all one has to do is to share a good idea with a group of people and they will do what they are told while doing it well. Nothing could be further from the truth. Change requires understanding, support and a high degree of ownership to be successful. People must grasp what the innovation means to them personally and how to put that innovation in place. They must believe that the change is necessary and achievable. Surrounding this understanding must be tangible evidence that there is support for the innovation from all quarters. Schools unfortunately have a history of "five year plans" that never make it through the second year. It is no wonder that many teachers dismiss innovation without even examining the relative advantages of any given proposal. Teachers have learned from long experience that the school probably will not follow through.

Fullan (1990) is a guiding force in the area of educational changes and from him that the following principles regarding such change have been adapted.

1) Recognize that change is a gradual process for teachers;
2) Note that change is a highly personal experience;
3) Realize that change is accomplished by individuals, not institutions;
4) Ensure that teachers received regular feedback on student progress;

5) Provide continual support and follow-up after the initial training.

The purpose of this article is to familiarize those interested in changing the focus to S/T/S with the models for innovation that should be consulted to help insure success. There are several special concerns relative to science, technology and society programs that should be considered. In the following sections such concerns will be examined.

S/T/S and the Changing Roles of Teachers

The successful implementation of an S/T/S approach in science teaching requires that teachers make several changes. The teacher is perhaps the single most important component of the change process. While students, parents, and administrators need to respond and react differently, the teacher is central to causing and supporting the changes in the classroom.

In a broad sense, the teacher must change their personal views of teaching and learning. The teacher must "step back" while encouraging students to take a more active role in the classroom. In the S/T/S classroom, teachers must allow the students the freedom to make decisions about the issues they will study, the questions investigated, and the resources consulted.

The changes that take place vary depending upon the philosophy of the individual teacher. The following list contains specific changes that should occur in teachers best to support the move toward S/T/S. As with similar tables found elsewhere in this paper, the factors here are a summary of items identified by hundreds of teachers who have participated in the University of Iowa inservice programs. Individual teachers need to assess where they stand with respect to each strategy, and make the appropriate changes.

Change is a gradual process. Teachers can develop a plan for implementing changes over time by evaluating where they stand currently and identifying where they would ideally like to be. While the strategies listed may serve as goals for most S/T/S teachers, the individual strategies will be accomplished to varying degrees, and at different rates, for each individual teacher.

Teachers can facilitate an S/T/S approach by:

- expecting students to identify the issues/topic for investigation;
- organizing instruction around relevant topics;
- fostering questioning in their students;
- encouraging students to seek out answers to their questions;
- encouraging students to use a variety of resources to answer their questions;
- evaluating and assessing students using an expanded range of instruments;
- providing opportunities for students to apply concepts and skills to new situations;
- advocating that students take social action where appropriate;
- extending science investigations to other areas of the school curriculum and community.

What goes on in most traditional classrooms can be compared with a theatrical production. Traditionally, the teacher serves as the director, selecting the script (textbook), determining who will play the various roles, and setting the production schedule. The performance lacks creativity and requires little independent thought by the actors (students). In an S/T/S classroom, the teacher is still central to the process, but assumes a different role. This time teaching is like improvisation theater, with the director overseeing, but not predetermining, the production. The students develop the script based on their needs and concerns. In the long term, the performance is more creative, requires a far greater degree of skill, and is considerably more challenging and enjoyable for the actors. It is the director who must believe in the actors enough to give up some control and decision making. The teacher is the key in allowing this to happen!

The Changing Roles of Students

Fullan (1982) asks the following question when considering the impact of educational change of students, "what would happen if we treated the students as someone whose opinion mattered in the introduction and implementation of change in school?" This question will be addressed in this section focusing on students as vital constituents of the educational community.

Earlier we stated that change is a process not an event. To understand the impact and significance of S/T/S on a student we need to examine what is asked of students as they are confronted with the expectations inherent in S/T/S programs. For example, consider that most teachers rely primarily on textbooks in science class while science, technology and society programs are, by their very nature, issue-based. Students who are accustomed to learning science in teacher-directed, textbook oriented, classrooms may have some initial problems when entering classes with S/T/S as the approach. If the change to an issue-based approach is to be effectively completed, the previous experiences and present attitudes of the students must be considered. The change process must include a period of orientation and support for these students. The teacher should model an inquiry approach and understand that some students may require more time than others to make the shift to the S/T/S strategy. The goal in S/T/S classrooms is to encourage students to become lifelong learners who are aware of the connections between science class and society. We want to take students from passivity to activity, but for this to happen teachers must be facilitators rather than learning directors.

Students in issue-based classrooms should:

- become active learners not just passive recipients;
- take increased responsibility for charting direction of the class;

- ask questions that require more than a textbook answer;
- look outside the science classroom for answers to questions;
- learn to use community resources;
- help to identify issues of personal and classroom interest;
- apply information learned in the classroom to real world situations;
- become a change agent;
- understand the impact of science and technology on the community;
- act in a responsible way based upon these new understandings;
- understand the importance of being scientifically literate;
- continue their personal education beyond formal schooling.

The preceding list of goals is ambitious, and not all students will achieve every desired outcome. It should be obvious that the complexity and variety of these goals will require that students think about science class in a very different way; students who have been successful in past science classes may resent that fact that the *rules* are shifting. Only by acknowledging the fact that students will have to change, and that change is inherently difficult, can we make the successful transition to S/T/S.

Changing Roles of Administrators

Schools today are faced with the challenge of restructuring educational programs to meet the needs of all students. History is marked with many attempts to rethink how schools could be more effective; knowledge of these past efforts suggests present questions. How are the current reform efforts different from those of the past? How will the structure of relationships within a school change as these transformations occur? What role will administrators play in orchestrating needed changes in the schools of tomorrow? Research addressing effective schools suggests that administrators are key agents of change within a school or district. This section of our paper will focus on how administrators make a difference in the move toward S/T/S.

Much research has been aimed at the study of effective leadership. Many theories

Administrators can either sabotage, ignore, or actively support the process, but must continually be aware that change is always a dynamic operation. If the change to an S/T/S focus is to be successful, administrators must become builders rather than blockers. The following list illustrates some changes that should occur in administrations as educational organizations and programs toward an S/T/S perspective.

Administrators can provide support for S/T/S programs by:

- viewing change in a dynamic and positive light;
- being approachable and open to new ideas;
- being goal oriented and focused on finding evidence that illustrates success;
- realizing that teachers, faculty members, students and parents are valuable resources in school restructuring;
- celebrating the successes and recognizing achievements of those in the school;
- recognizing the level of concern regarding the innovation in each staff member;
- facilitating change through creative scheduling;
- serving as a resource provider for teachers;
- allowing teachers time to brainstorm innovative ideas;
- involving teachers in plans for staff development while sharing the vision of change;
- providing release time for professional development;
- helping teachers work together as members of a team while providing the time for this to occur;
- allowing lesson plans to reflect personal teaching styles of individual educators.

Challenges faced by administrators in restructured schools will be different if the improvements are to be anything but superficial and temporary adjustments. The challenge of tomorrow's administrators is to articulate a clear vision while maintaining and, in some cases, restoring the public's confidence in our schools.

Changing Roles of the Community: Focus on Parents, Universities and Businesses.

If the change in focus is to be successful, links must be forged between schools themselves and the community at large to foster understanding, cooperation and support. Parents and industry represent the most potent ties to schools because these two have been proposed to explain what leaders do, how they think, and how they react in varying situations so common in schools. Persell and Cookson (1982) reviewed more than 75 research studies examining the qualities of effective administrators. These studies revealed that strong administrators:

- demonstrate a commitment to academic goals;
- create a climate of high expectations;
- function as instructional leaders;
- are forceful and dynamic leaders;
- consult effectively with others;
- maintain order and discipline;
- marshall resources;
- use time well;
- evaluate and assess results.

These general characteristics of effective administrators are important in schools undergoing transition to new programs than in schools simply maintaining an educational philosophy. The descriptions of the ideal administrator are useful in getting us to think about the type of leader needed for a specific situation -- such as those who encourage the transition to an S/T/S format.

School administrators themselves must realize that there are no guaranteed recipes for change, because of the "people factor." People do not always conform to a standard and will themselves change during the process of innovation. Administrators and school boards must work with teachers, student and parents in developing guidelines that support the changes occurring within the school. Perhaps the most common errors in judgement made by administrators is their lack of understanding that, following an inservice workshop, all teachers do not simply do what they are told to do. Conflicts and problems are inevitable as people go about the business of pursuing goals over time. Patience and insight are important ingredients the administrator can bring to this process.

constituencies clearly have a vested interest in assuring success in the school environment. Parents want their children to excel, and industry is interested in guaranteeing a qualified work force.

Parents have voiced some concerns that S/T/S is not science, and to a degree they are correct. S/T/S programs, if properly designed, are not like the fact-oriented, teacher-directed science classes they remember from personal school experiences. However, scientific concepts and principles are communicated to students in an S/T/S teaching environment as well. This potential for misunderstanding must be addressed by schools when talking with parents and discussing why the change is necessary and desirable.

Conscientious parents have long supported their own children as they progress through school and there is no reason to expect that will end. In fact, the role of the parent will become more clearly defined. The shift toward classes with an S/T/S emphasis may serve to attract more parental involvement since parents can now be both supporter and resource for their children. Listed below are some methods we have found to increase parental participation. These factors are particularly important as parents assist their children in the move toward an understanding of the interrelationships between science, technology and society.

Parents can provide support for the S/T/S focus by:

- encouraging their children to question the world around them;
- talking with their children about social-scientific issues;
- assuring that their children see the connection between the real world and what is discussed in school by promoting interest in current events featuring S/T/S problems and issues;
- maintaining communication between the home and school with respect to academic achievement and involvement;
- advocating a change in traditional grade reporting schemes;
- taking their children to the library to investigate current problems of interest;
- acting as an in-school resource to discuss issues with the entire class;

- taking their children to places of interest such as the local landfill sewage treatment plant or similar facilities;
- furnishing small amounts of incidental financial backing to students and schools for S/T/S-related projects.

The community at large, including colleges, universities and businesses play their important role in the S/T/S movement too. *Partnership* is perhaps the best single word to describe the function of the community in supporting science, technology and society programs. As Atkin and Atkin (1989) point out, "partnerships, alliances, cooperatives and collaboratives are among the new watchwords on the education policy and innovation scene." The lists below illustrate ways in which these institutions can support and foster the development of science, technology and society programs.

Colleges and Universities can support an S/T/S focus by:

- designing appropriate inservice programs and summer institutes to meet teacher needs;
- arranging full-scale program implementation and administration of S/T/S initiatives;
- making opportunities for mentorships available between university scientists and students;
- developing collaborative research and development programs;
- establishing scientist/science teacher partnerships.

Businesses and the Corporate Community can support an S/T/S focus by:

- making mentorship opportunities available between corporate scientists and students;
- loaning scientists to advise students and teach courses;
- establishing scientist/science teacher partnerships;
- making financial contributions that include both major funding for programs and mini-grants for teacher initiatives;
- donating unneeded equipment or facilities to S/T/S programs;
- celebrating and publicly acknowledging the successes of partnerships;
- maintaining an advocacy stance in the community for S/T/S education;
- giving political support for specific science programs and general education.

Final Thoughts

Some have likened the change process to an ecosystem in which the various parts are intimately intertwined, one affecting the next. This is equally true of the complex relationships involved in education. The health of the system is dependent upon assuring that all parts function in concert. Educational change can occur smoothly and successfully only if all participants are considered. Changes forced onto systems and changes that neglect participation of certain principal parties may be momentarily successful, but the long term prospect for permanent change are bleak. Only by working together, considering the goals and feelings of all those affected by the transition, can any change in education be assured. The shift to a science, technology and society focus, with its dual teaching and curriculum orientations, is a worthy goal and can occur only if all elements of the school ecosystem are part of the process.

References

Atkin, J.M. and Atkin, A. (1989). Improving Science Education Through Local Alliances: Report to the Carnegie Corporation of New York. Santa Cruz, CA: Network Publications.

Fullan, M. G. (1990). Staff development, innovation and institutional development. In Joyce, B. (ed.) Changing School Culture Through Staff Development. Alexandria, VA: Association for Supervision and Curriculum Development.

Fullan, M. G. (1982). The Meaning of Educational Change. New York: Teachers College Press.

Goodlad, J.I. (1984). A Place Called School. New York: McGraw-Hill.

NSTA (1990). Science/technology/society: a new effort for providing appropriate science for all. Bulletin of Science Technology and Society, 20, 249-250.

Persell, C., & Cookson P. (1982). The effect of principals in action. In The Effective Principal: A Research Summary. Reston VA: National Association of Secondary School Principals.

PERSONALIZATION: THE MISSING ELEMENT IN STS EDUCATION

Paul C. Jablon
School of Education
Brooklyn College
2210 James Hall
Bedford Ave & Ave H
Brooklyn, N.Y. 11210
(718) 780 5061

STS (Science, Technology, and Society) based classes appeal to the innate desires of young people "to make a difference" in their world through the attention paid to social conscience issues and the students ability to consequently act upon their decisions about the issues through letter writing, direct community involvement, or some other action. However, many times when teachers introduce STS issues such as solid waste management, genetic engineering, and such, they are surprised to find that many students are not motivated by them. And for those students who initially demonstrated an interest, their attention either is sporadic, or wanes completely.

Yet there are some STS programs that have the ability to sustain a deep student interest throughout the semester. Some of these programs have even utilized an STS format with great success with students who have been labeled "at-risk." (Jablon and Born, 1988) If we look at the nature of human beings, and the nature of adolescents in particular, some of the underlying reasons for this success in engaging students with STS become clarified.

Most adolescents, but especially at-risk students, do not have their security, love, or self-esteem needs met - as defined by Maslow's hierarchy of needs (1968). Yet most of what we do in schools is to ask students to work within the realm of self-actualization, saying that these things they are asked to study they will need "some day" or for the "betterment of society." Rarely are they engaged in any activities in the academic classroom that will fill their immediate needs for the lower level foundational elements. Needs that if not addressed, disallow the student from engaging in the self-actualized activity we present. Many students not finding any of these more emotional needs being addressed in their academic classes, seek them in their anti-school, negative peer groups (Pulkkinen, 1982).

Underlying STS are psychological and sociological relationships. Over the years, teachers found that most of these big ideas and concepts that they wish students to acquire, whether in social studies, science, technology, or in the relationships of characters in novels, are universal relationships between individuals and groups, individuals and other individuals, or between groups and groups. They are in many ways based on the same psychological and sociological foundations as the relationships these students are having with their peers and their parents, the two primary areas of concern to adolescents. If we allow students to role play selected real life situations between these individuals or groups that are analogous to interrelationships in social studies, science or literature situations, then students not only "experience" this larger, complex relationship we wish them to understand, but simultaneously meet these emotional needs. Once these needs are met, the students will not only engage in study of the analogous societal relationships, but will delve into the deepest esoteric questions that are posed. In addition, they acquire conflict resolution skills that they can utilize in their everyday interpersonal relationships.The personalization of the subject matter by having students investigate these *analogous interrelationships* between their own personal interrelationships and those that exist at a societal level is a central element of the most successful of these STS programs.(Jablon, 1989)

For example, having 3 students role play a situation between a 15 year old high school student who must work long hours to add to her family's income because a parent has recently died, her teacher who is upset by the drop in quality of the students work in her class, and the parent who is caught in between wanting the best for the student and the rest of her family's welfare, has allowed classes of students studying about the cutting of the rainforests to understand the complex relationship between the poor natives cutting the rainforests (the student), the government of the third world country who is encumbered with a large international debt (the parent), and the environmentalists trying to help both the native and the future world ecological situation (the teacher). Students not only had a unique insight into world economics, but into their own personal relationships and therefore identify positively with their academic classes. If the psychological needs of the students are met as they are engaged in activities with the other students in the STS based class, then a positive alternative peer group is created that students can go to as an alternative to their negative neighborhood peer groups where they normally turn in their search for their need fulfillment.

If this method of personalizing subject matter is utilized only in the science classroom, even though the STS format facilitates the ease with which it can be integrated, teachers become frustrated with the amount of science concepts that cannot be addressed because much of the issues engendered fall better into the social studies or language arts arenas. If subject areas - science and language arts, science and social studies, or all three - are integrated together and taught in a truly interdisciplinary manner, then the personalization mechanism supports completely the areas being studied.

I have had the opportunity to present workshops to teachers and supervisors at conferences throughout the the country. After they have watched videos of some of these programs in operation, listened to personal anecdotes from teachers who have taught in these programs, engaged in personalizing role playing themselves, and followed this with some broadstroke interdisciplinary planning, they became animated, vitalized and truly intrigued with the idea of utilizing this format for their own classrooms. Yet very few ever actually initiated such changes, for both the teachers and supervisors were generally not prepared to engage students in these type of activities. There is a pressing need for both preservice and inservice training. Few, if any, teacher preparation programs have either an interdisciplinary or analogous interrelationship/role playing component. Most education faculty have never themselves taught in this manner, and therefore cannot act as trainers for their preservice or masters level inservice students. Supervisory personnel in the schools generally fall into the same category.

There is, therefore, a necessity for the creation of nationwide institutes to begin this training process so that it can have a domino effect throughout state and local school systems.

References:

Jablon, P. (1989). A documentation and impact analysis of a project-oriented, interdisciplinary, team-taught, peer-influence program for secondary schools and its effects upon science learning. Unpublished doctoral dissertation, New York University.

Jablon, P. and Born, T. (1988). STS works in the city. *SSTS Reporter*. April 1988.

Maslow, A. (1968).*Toward a Psychology of Being.* Princeton, N.J.: Van Nostrand.

Pulkkinen, L. (1982). Self-control and continuity from childhood to adolescence. In Baltes, P. & Brim, O. (Eds.) *Life-span development and behavior* Vol. 4. New York: Academic Press, 64-102.

A CRITICAL PERSPECTIVE ON STS: STS, SCHOOL REFORM, AND CORPORATE CONCEPTIONS OF EDUCATION FOR WORK.

Raymond R. Grosshans
Assistant Professor
Industrial Technologies
Rochester Institute of Technology
National Technical Institute for the Deaf
Rochester, NY 14623
(716) 475-6382

My paper today focuses on corporate conceptions of education in relation to technological changes in the work place. The position I take in this paper regarding corporations is extensively informed by the work of the industrial sociologist Ivar Berg (1970, 1978, 1979). Berg's work is especially important as his analyses of education, work, and technology remain focused on people and their actions and are not distracted by institutional facades or bureaucratic flummery: People, both individually and collectively, directly control technology -- no deus ex machina, no black box, no shadowy forces. Technology under human control, as Berg notes, "simply forces a very limited number of particular and predictable social relationships on a population to the exclusion of alternative relationships" (1979, 12-13). In our society and in our culture, many of us expect our work lives to be hierarchically ordered and antagonistic. We expect to be sorted and selected, rewarded or discarded, according to our economic utility. We expect the separation of mental work from manual work and the separation of work from pleasure. It is through such experiences in our working lives that many of us first become aware of our stake in technology.

My talk today stems from a question that I have regarding the role that STS might play in society, a question that I believe is much on the minds of the STS community: Will STS abet the maintenance of the hierarchical and antagonistic social relationships that often result from existing means of controlling technology? Or, alternately, will STS abet the expansion of society's role in controlling technology toward democratic ends? Clearly, STS embraces the latter role while decrying the former.

National Association for Science Technology and Society (NASTS) conference participants and Bulletin of Science, Technology, and Society authors routinely promote the expansion of democratic participation through science and technology education. For example, in a recent Bulletin, one author contends that the "wise application of our technology" will derive from democratic processes if we educate "our citizenry about the interactions of technology with society" (Kranzberg 1990, 11). Bulletin authors routinely promote STS to reverse present levels of "scientific illiteracy in America" (Kumar 1990, 290) to prepare "students to meet the challenges of a technological society" (Rhoton and Pafford 1990, 305). And another author, a political scientist who Morris Shamos, a NASTS board member, recently castigated in the December 1990 NASTS News as ignorant of science and as a mocker of science, even this author promotes STS studies to "inform important deliberations humanity now faces" (Winner 1990, 13).

By raising this question today, I draw attention not to the aims -- the ends -- of the STS community; instead, my concern is with STS means. Specifically, I am concerned about linkages between the STS community and the other communities currently shaping the nature and content of American education.

STS is in a particular moment in its social and historical development: STS is inventing itself as an academic discipline and it quests for social power. STS is attempting to create a location and a role for itself within existing institutional structures and in academic and in political discourse. To do this, STS leaders routinely link STS aims and STS issues with the aims and issues of other players who compete for resources and attention. For example, the current editor-in-chief of the NASTS Bulletin, insists that "the integration of S&T [science and technology] into culture," is "the single greatest educational challenge." STS, it is argued is "the new heart of General Education" (Roy 1990, i). To make a point about the nature of STS, the chair of the ethics and values theme for the 1991 NASTS conference and editor of the journal Science, Technology, and Human Values, argues that "STS is not a discipline . . . .it is a movement" that responds to problems including "most of the critical issues facing humanity: issues of peace and war, the environment, world health, [and] universal subsistence" (Cozzens, 1990: 1).

The link that the STS community forges, the link that concerns me, and one that connects STS to corporate conceptions of education and the work place, is the one between STS and the current educational reform movement. In the next few minutes, I will make explicit the origins of this movement and its themes and priorities. I also will give some examples of how STS proponents link these themes and priorities to STS goals.

Let's be clear: the current educational reform movement is a corporate-led movement. From the early 1980s through 1987, public and private commissions, task forces, and study panels issued over 300 corporate-initiated studies of education (Ray 1989, 122). The theme of these reports is the adjustment of education to rapidly changing U.S. labor markets. Typically, these reports represent recent labor market changes as the result of two developments: the so-called globalization of the economy; and, the inevitable emergence of new production technologies which demand from the work force higher levels of skill. To keep pace with rapidly changing labor markets, corporate-led reformers argue that the U.S. educational system must be reformed to correspond with economic and technological developments. Such a corresponding relationship, according to reformers, will develop a flexible, highly-skilled work force that can compete effectively in the world economy. In this formulation, a direct relationship between education and the economy is assumed to exist: namely, the weakened position of the U.S. in the world economy is directly attributable to flaws in the educational system.

Individual business and political leaders are active promoters of this formulation for educational reform (Rumberger 1989, 55). A recent, detailed analysis of the statements on education made by U.S. presidential candidates in 1984 and 1988 shows that the views of prominent politicians were "unremittingly suffused by corporate priorities" (Shapiro 1990, 3). Higher education policy processes also are conforming to corporate goals and priorities. Corporate leaders concerned with profitability and university leaders anxious over status and resources redefine basic science as entrepreneurial science (Slaughter 1990, 3 & 29).

The education reform formulation that promotes a corresponding relationship between education and the economy frequently appears in recent editions of the NASTS Bulletin. For example, One recent STS Bulletin author claims that "Public science illiteracy is indeed a national problem and could affect the United States democracy and economy" (Kumar 1990, 292). Others argue for the "integration" of STS into science curriculums as a means of "bringing about needed changes in education" (Rhoton and Pafford 1990, 305). These authors contend, echoing many others, "If students are to compete in a world economy, [students] must be technically literate" (Rhoton and Pafford 1990, 309). Still another, to buttress the argument that "the only viable goal for non-science majors is scientific literacy," employs such themes of the corporate-led educational reform movement as "global economic competitiveness," and "global economic wars" (Adams 1990, 125).

My sense is that at present, some members of the STS community see the educational reform movement both as an ally and as an opportunity. What I don't sense within the STS community is much awareness of the growing critique of the current educational reform movement. I will take several minutes to review this critique, with emphasis on its social dimension.

To introduce this critique, I begin with an historical example of an earlier corporate-led attempt to form a relationship of correspondence between the economy and education. In the decades which bracketed the turn of the twentieth century, in the face of two threats to industry profits, the threat of Germany's industrial might to American markets and the growing militancy of organized labor movements, leading industrialists pressed for schooling that would deliver to the factory gates a more skilled and compliant labor force. Acting through organizations including the National Association of

Manufacturers, the National Association of Corporate Schools, and the National Association for the Promotion of Industrial Education, industrialists were able to shape many of the features of public education, ones that we take for granted today. These features include factory-like school architecture, school day time-keeping procedures, and the tracking of students onto limited career paths.

The one feature of schooling that became a rallying point for both industrialists and educators was vocational education (voc ed). Taking the cue from powerful industrial and corporate interests, late-nineteenth and early-twentieth century educators aimed to develop through voc ed what was then termed "industrial intelligence," a close parallel to what some today call higher-order thinking skills. Also, voc ed proponents aimed to build a bridge between school and work (Wirth 1980, 23-31 & 33; Noble 1977, 237 & 308-310; Lazerson and Grubb 1974, 20). Today, there is consensus among vocational education researchers that voc ed -- for decades -- has failed to bridge between school and work. Indeed, the emergent research shows that for many students, vocational education participation impairs employability (Berryman 1981, 134; Lazerson and Grubb 1981; Carnoy and Levin 1985; Wilms 1981; Fitzgerald 1985). Nevertheless, increased public funding of voc ed typically is among the first responses of corporate leaders to questions of educational quality (see Ray, 1989 and Ray, 1990 for examples of this response). I suspect that what corporate leaders find important about voc ed is not its educational efficacy, but rather the lessons about structure and purpose that voc ed teaches to educators, students, and society, namely, the structure of schools is a stratified one into which people must be sorted and selected, and the purpose of schooling is to get jobs (see Kliebard, 1990). Although voc ed researchers don't find these lessons compelling, the federal government apparently does: voc ed is funded for this year to the tune of over one and one-half billion dollars.

Based on the history of earlier interactions between private interests and educational reform, of which voc ed is one brief example, the STS community should be wary of the current corporate-led educational reform movement. However, there is another critique of the current corporate-led educational reform movement, one that goes right to the heart of STS aims to further the democratization of society through science and technology education. Critics claim that social biases manifest in the ideological origins, content, and goals of the educational reform movement will undermine significant, meaningful educational reform. These critics use as their primary evidence the social, political, and economic outcomes of widespread, institutionalized social bias.

Social bias and stratification in the U.S. is the result of the complex and overlapping dynamics of bigotry and discrimination. Persons within the bottom strata experience systematic disadvantages in terms of schooling, types of jobs, and rewards from jobs (Berg 1979, 65). A 1985 study sponsored by the National Institute of Education found that "a large part of the problem [the effects of discrimination on employment] lies in . . .continued patterns of employer discrimination in hiring and compensation" (Fitzgerald 1985, 6-11). Put plainly, neo-individualist ideologies such as human capital mask "the discriminatory values and preferences of the citizens of a society" (Berg 1979, 66).

Some critics argue that the educational reform movement of the 1980s originated in "pattern[s] of social resentment" and is characterized by "support for a more conservative educational agenda" (Burbules and Kantor, 1988: 189). Others see school reform as part of a wider "conservative restoration" (Shor, 1986). Similarly, some see the current moment of educational reform as an element of neo-conservative efforts to align school expansion and reform efforts with new work force disciplines (Carnoy and Levin, 1985: 179). More harshly, some critics see in the current moment of educational reform the reassertion of such odious social doctrines as Social Darwinism (Apple 1988, 168-170) and biologism (Luke, 1988 and Rose et al. 1984).

At center of many proposals for educational reform are such traditional American ideals as self-help, economic autonomy, and voluntary association. The conflation of such traditional ideals with narrow capitalist priorities, a construct that confounds personal rights and property rights, is termed by some critics "neo-individualism" (O'Connor 1984, 236) or "authoritarian populism" (Apple 1988, 171) or neo-conservatism. In this construct, democracy is partly redefined as the right to consumer choice not the right to political choice. Thus you can choose between a Ford or a Chevy, but you can't choose between peace and war. In this construct education is redefined as human capital formation. Human capital formation dominates the economics of education literature (Levin 1989, 14; Olszewski 1981, 89). In human capital models of schooling, schools are valuable to society because they provide "the forms of knowledge, skills, and social practices necessary to produce the labor force for an increasingly complex, technological economy" (Giroux 1984, 188). One brief example of a reform proposal based on human capital models is the proposal for school reform through school choice. Proponents of school choice see schools as marketplaces from which individuals pick and choose preferred educational methods and contents (see Mickelson 1990, 13-18; Wexler 1987, 73). In sum, critics anticipate that intensified social stratification along lines of class, race, and gender will result from this reform movement.

The possibility of increased social stratification resulting from educational reform is especially ominous in light of recent predictions of a major shift in the demographic composition of American society. This shift results from decreasing birth rates among white Americans and increasing birth rates among black Americans, hispanic Americans, and other members of minority groups within the U.S. population immigration (Pallas et al. 1989; Marshall 1988; Carnevale 1983). Therefore, a much larger proportion of the young people attempting to enter U.S. labor markets will be from that segment of the population that heretofore has experienced the least labor market success due to the aggregate effects of the long-term, institutionalized stratification of American society.

Social bias plays a foundational role in U.S. institutions, especially in determining patterns of employment. Thus, the role of technology in shaping labor markets is "significantly countered and exaggerated by the practices of individuals and groups, and by the policies and practices of larger collectivities and formally organized public and private agencies" (Berg 1979, 68). In these ways, social taste and preference, embodied and masked in such values as "justice, efficiency, and equity," profoundly influence the relationship between technology and employment (Berg 1979, 68). The sectoral buffeting (rapid changes in levels of employment in specific industries) often ascribed to technological change is to a large extent the result of social technologies, that is "job classifications, skills hierarchies, disciplinary and supervisory arrangements, work group membership patterns, and organizational rules" (Berg 1979, 71). Accordingly, the "effects of technological changes are generally selective in their incidence, generally slow moving, and usually caught up together with parallel and intervening forces" (Berg 1979, 71).

As I said earlier, my efforts today aim to bring to the attention of the STS community critiques of the corporate-led educational reform movement. This critique emphasizes the potential of corporate-led educational reform to intensify social stratification. My point here is not to castigate individuals or classes of individuals, but instead to highlight the extent to which human passions, tastes, and preferences shape American society including its work places and schools. To round out this point, I will turn now to corporate conceptions of the job market for youths, and, education and technology.

Ivar Berg, in his book Industrial Sociology makes the point that business leaders are "disposed both to deny that they are powerful and to seek to ground their admittedly significant roles in society in terms that will clothe them with legitimacy" (Berg 1979, 115). Berg argues that business leaders see themselves as "rational decision makers . . .as a more passive than active force . . .in economic affairs"; business leaders legitimize their activities as the "essentially unintended consequences of the actions of property holders simply pursuing the freedoms given affirmative sanction in law and in tradition" (Berg 1979, 115).

When it comes to questions of education, business leaders and advocates of their agendas typically overlook cause and effect relationships between business decision-making processes and ensuing negative outcomes. Instead, in their justificatory rhetoric, corporate leaders typically set aside considerations of their responsibilities and focus on the retraining of workers and students to correct productivity problems and structural economic problems. For example, while conceding that declining productivity rates are related to "the lack of investment in technological innovations, new plants and equipment, and adequate skill training," one recent analysis argues that solutions to productivity problems are to be found in the training and retraining of workers "who can use and maintain the high technology of the future" (Taylor et al. 1982, 7). Similarly, in the "elitist" microeconomic theories popular with business leaders and conservative politicians (Marshall 1987, 304), unemployment is attributed to either "job/skill mismatch[es]" or workers' personal preferences and not to the consequences of structural flaws in the U.S. economy (Duboff 1977, 18).

The selective focus of corporate conceptions of education and jobs is clearly evident in assumptions about the so-called 'bridge' between school and work. Such assumptions rely heavily upon status attainment analyses that claim to show correspondence between school achievement and labor market success (ie: Blau and Duncan 1967). Employers routinely insist on the adjustment of school credentialing procedures to guarantee the quality of the school's product. Employers assume that school achievement corresponds with labor market success. They seem to believe that uniformly high quality graduates will all successfully cross the bridge from school to work.

What employers miss is the relative unimportance of school achievement in the labor market experiences of "non-college youth" (Grant Foundation 1988). A recent Grant Foundation report insists that the key to understanding the bridge between school and work is that the primary problem lies with the economy and the pathways by which youths enter economic life and not with the youth themselves (Grant Foundation 1988, 3). Labor markets for non-college youth are "highly disorganized": most youths locate first jobs on their own and gain work experience in casual, unskilled jobs (Doeringer and Vermeulen 1981, 9). School achievement has little to do with such labor markets. For one-half or more of American youths, U.S. employers rely more upon personal recommendations, acquaintanceship, and family connection than on credentials when making hiring decisions (Berg 1979, 27). School credentials, along with employment histories and psychological test results, are for many employers simply indicators of the work habits, attitudes, and interpersonal skills that they value over literacy and computational skills (Aronowitz 1973; Doeringer and Vermeulen 1981; Berryman 1981; Fitzgerald 1985). Status attainment research which claims to show linkages between years of schooling and labor market success has little explanatory power regarding the differential work experiences of women, minorities, and youth (Carnoy and Levin 1985, 102-104; Fitzgerald 1985, 5-11; Anyon 1981).

Youth unemployment is worse now than in the past due to two factors, neither of which relates to schooling. First, there has been a widespread decline in unskilled and agricultural employment, the traditional points of entry to the secondary labor market for youth. And second, the labor market participation of adult women and immigrants has increased significantly. These new participants tend to compete directly with youth in secondary labor markets (Marshall 1988, 175). As Doeringer and Vermeulen point out, "Much of the problem in moving youth into adult jobs stems from the unwillingness of large, career employers to hire youth" (1981, 17). Non-college youth who don't enter employment, are often trapped in a vicious cycle; many, if not most, employability skills "are learned mainly on the job" (Fitzgerald 1985, 33).

Regarding corporate conceptions of technology and education: Perceptions of the general relationship between technology and employment are confused. To some extent this confusion stems from cases in which uneven technological development and diffusion, primarily intended to reduce production costs by controlling labor costs, have resulted in the need for some workers with higher skills. And, this confusion reflects the fact that many technology-intensive manufacturing installations were placed in service during two closely spaced recessions in the 1970s and 1980s. Uneven labor market responses to recessionary conditions have made it difficult to gauge the effects of technology on employment. According to the Office of Technology Assessment, production technologies are secondary influences on the level of employment "dwarfed" by the effects of the short-term business cycle and long-term structural change (OTA 1984, 102-103). Furthermore, this confusion is compounded by the fact that "virtually every application [of high tech equipment] is a prototype" (OTA 1984, 5). Because of the experimental nature of such equipment, it is difficult to gauge not only its effects on labor markets, but also its effects on the production process itself. One recent study of a technology-intensive manufacturing installation finds that 60 percent of its reported benefits are due to reorganization of production processes, while only 40 percent are due to the installation itself (Ebel 1985, 135-137).

Central to corporate conceptions of education and technology is the assumption that emerging production technologies will require workers to attain higher levels of skill both to keep their jobs and to maintain their income levels. However, despite the relentless promotion of this assumption by educational reformers, business leaders, and the press (Rumberger, 1989), there is little clear evidence that emerging production technologies will require the development of higher skills. According to a recent report from the National Academy of Sciences:

> The empirical evidence of technology's effects on skills is too fragmentary and mixed to support confident predictions of aggregate skill impacts.

> Despite this uncertainty, the evidence suggests that the skill requirements for entry into future jobs will not be radically upgraded from those of current jobs. (Cyert and Mowery 1987, 103)

And, in an interview study conducted by the National Research Council, managers of successful technology-intensive manufacturing installations claimed "that many workers already had the basic skills to do more than they had been asked to do in the past and could be trained to do still more." According to these high-tech managers, these basic skills are those that workers "use around their homes and automobiles" (NRC 1986, 102-105). Such findings echo earlier work done by Levin and Rumberger using Bureau of Labor Statistics estimates of the growth and composition of future labor markets. They found that "Of the 20 occupations expected to generate the most jobs in the economy during this period, not one is related to high technology" (1983, 4). Furthermore, Levin and Rumberger found that "employment growth will favor jobs that require little or no training beyond the high school level" (1983, 6).

To summarize, according to critics, business and political leaders dominate the current educational reform movement; these leaders will not tolerate the economic, social, and political changes necessary to accomplish significant educational reform. In this critical view, the structural effect of social bias, which is enacted, maintained, and reproduced by existing institutions, dead-end education in cycles of meaningless reform.

What accounts for corporate leaders' interest in educational reform? If the critics are right, educational reform really means more of the same; so, why do corporate leaders bother? One answer is that corporate leaders wish to shift attention away from their failings and away from structural weaknesses in modern capitalism. The rhetoric of the corporate-led educational reform movement puts the blame for current economic conditions squarely on the shoulders of school teachers and school kids (when they're not blaming unscrupulous foreign competitors). By blaming the victim, so to speak, corporate leaders neatly sidestep "examination of their role in exacerbating domestic poverty through the expansion of unstable jobs that offer low annual wages, no security, and few advancement possibilities" (Ray 1990, 187).

Another answer is that corporate interests favor "tight-money/high-unemployment macroeconomic policies" as a means of driving down wages and by that increasing profits (Piven 1982: 126-8). According to one recent study of a joint corporate-school educational reform program, business leaders' real agenda is to use schooling to gain leverage over intransigent youths during a period of tight labor markets (Ray 1989, 126). This interpretation squares with corporate leaders persistent interest in vocational education programs. Remember the lessons taught by voc ed -- get sorted, get a job. According to one prominent corporate leader, the real problem with education is not the schools per se but is instead the non-college bound students who don't have the skills and discipline required by employers who depend upon secondary labor markets (Ray 1989, 127). Put another way, by a promoter of the education/economy link, "jobs are becoming dead-end because people are dead-end (Berryman 1988, 3).

What does this mean to the STS community? Briefly, I think this critique means that STS must consider carefully the nature and purpose of any movement or agency with which STS might align itself. Especially in this period when the STS community is inventing its disciplinary identity, STS should avoid linkages that undermine STS goals.

In closing, while the critique of the corporate-led educational reform movement that I have reviewed today raises a number of questions, I shall conclude with the question I began with: In what type of society does STS wish to play a role? If STS will expand democratic participation through science and technology education, then STS must emphasize its disciplinary interest in social literacy, that is, learning to choose. No longer can we permit self-interested individuals to hide behind science and technology and education and to shape our society according to a discriminatory social calculus antithetical to the expressed aims of STS.

References

Adams, D. (1990). Science education for non-majors: The goal is literacy, the method is separate courses. Bulletin of Science, Technology, and Society, 10 (5 & 6), 125-129.

Anyon, J. (1981). Social class and school knowledge. Curriculum Inquiry 11 (1), 3-42.

Apple, M. (1988). Redefining equality: Authoritarian populism and the conservative restoration. Teachers College Record 90 (2), 167-184.

Aronowitz, S. (1973). False promises: The shaping of american working class consciousness. New York: McGraw-Hill.

Berg, I. Education and jobs: The great training robbery. New York: Praeger.

Berg, I., M. Freedman, and M. Freeman. (1978). Managers and Work Reform: A Limited Engagement. New York: The Free Press.

Berg, I. (1979). Industrial sociology. New Jersey: Prentice-Hall.

Berryman, S. (1981). Vocational education and the work establishment of youth. In P. Doeringer and B. Vermeulen (Eds.), Jobs and Training in the Eighties, (pp. 118-157). Boston, MA: Martinus Nijhoff.

Berryman, S. (1988). The educational challenge of the american economy. Briefing paper prepared for the National Educational Association, Washington, D.C.

Blau, P.M. and O.D. Duncan. (1967). The American Occupational Structure. New York: Wiley.

Burbules, N. and H. Kantor. (1988). 'Redefining equality' reconsidered. Teachers College Record 90 (2), 185-191.

Carnevale, A. (1983). Human capital: A high yield corporate investment. Washington, D.C.: American Society for Training and Development.

Carnoy, M. and H. Levin. (1985). Schooling and work in the democratic state. Stanford: Stanford University Press.

Cozzens, S. (1990). The disappearing disciplines of STS. Bulletin of Science, Technology, and Society 10, (1), 1-5.

Cyert, R.M. and D.C. Mowery eds (1987). Technology and employment: Report of the panel on technology and employment, committee on science, engineering, and public policy. Washington, D.C.: National Academy Press.

Doeringer, P. (1981). Occupational education and training for the 1980s. In Peter B. Doeringer and Bruce Vermeulen (Eds.), Jobs and Training in the Eighties (pp. 1-17). Boston, MA: Martinus Nijhoff.

DuBoff, R. (1977). Full employment: The history of a receding target. Politics and Society 7, 1-25.

Ebel, K. (1985). Social and labor implications of flexible manufacturing systems. International Labour Review 124 (2), 133-145.

Fitzgerald, L. (1985). Education and work: The essential tension. Columbus, Ohio: The National Center for Research in Vocational Education.

Giroux, H. (1984). Public philosophy and the crisis in education. Harvard Educational Review 54 (2), 186-194.

Grant Commission. (1988). The forgotten half: Non-college youth in America. Washington, DC: Youth and America's Future: The William T. Grant Commission on Work, Family and Citizenship.

Grubb, W.N. and M. Lazerson. (1988). Broken promises: How Americans fail their children. University of Chicago Press.

Grubb, W. N. and M. Lazerson. (1981). Vocational solutions to youth problems: The persistent frustrations of the American experience. Educational Analysis 3 (2), 91-104.

Kliebard, H. (1990). Vocational education as symbolic action: Connecting schooling with the workplace. American Educational Research Journal 27 (1), 9-28.

Kranzberg, M. (1990). The uses of history in studies of science, technology, and society. Bulletin of Science, Technology, and Society 10 (1), 6-11.

Kumar, D. (1990). Knowledge for democracy: Communicating science for knowledge equity. Bulletin of Science, Technology, and Society 10 (5 & 6), 290-292.

Lazerson, M. and W. Grubb. (1974). American education and vocationalism: A documentary history, 1870-1970. New York: Teachers College Press.

Levin, H. and R. Rumberger. (1983). The educational implications of high technology. Stanford, CA: Institute for Research on Educational Finance and Governance, School of Education.

Levin, H. (1990). Mapping the economics of education: An introductory essay. Educational Researcher 18 (4), 13-16.

Luke, A. (1988). Literacy, textbooks, and ideology. New York: Falmer Press.

Marshall, R. (1987). Unheard voices. New York: Basic Books.

Marshall, R. (1988). The shifting structure of global employment. In J.W. Sewell and S.K. Tucker (Eds.), Growth, Exports and Jobs in a Changing World Economy -- Agenda 1988. New Brunswick and Oxford: Transaction Books.

Mickelson, R. and C. Ray. (1990). Markets, values, and the business vision for school reform: A retreat from educational equity. Humanity and Society (November).

National Research Council, Committee on the Effective Implementation of Advanced Manufacturing Technology. (1986). Report of the committee on the effective implementation of advanced manufacturing technology, cited in A. Ashburn. (1986). People and automation. American Machinist and Automated Manufacturing (June), 98-112.

Noble, D. (1977). America by design: Science, technology, and the rise of corporate capitalism. New York: Knopf.

O'Connor, J. (1984). Accumulation crisis. London: Basil Blackwell.

Office of Technology Assessment. (1984). Computerized manufacturing automation: Employment, education, and the workplace. Washington, DC: U.S. Government Printing Office.

Olszewski, D. (1981). Career paths and vocational education. In P. Doeringer and B. Vermeulen (Eds.), Jobs and Training in the Eighties (pp. 88-117). Boston, MA: Martinus Nijhoff.

Pallas, A., G. Natriello, and E. McDill. (1990). The changing nature of the disadvantaged population: Current dimensions and future trends. Educational Researcher 18 (5), 16-22.

Piven, F.F. and R.A. Cloward. (1982). The New Class War. New York: Pantheon.

Ray, C. and R. Mickelson. (1990). Corporate leaders, resistant youth, and school reform in sunbelt city: The political economy of education. Social Problems 37 (2), 178-190.

Ray, C. and R. Mickelson. (1989). Business leaders and the politics of school reform. Politics of Education Association Yearbook, 119-135.

Rhoton, J. and W. Pafford. (1990). Training in service teachers for improved skills in science and technology education. Bulletin of Science, Technology, and Society 10 (5 & 6), 305-309.

Rose, S., S. Lewontin, and L. Kamin. (1984). Not in our genes: Biology, ideology, and human nature. Harmondsworth, UK: Penguin.

Roy, R. (1990). Ten years young. Bulletin of Science, Technology, and Society 10 (1), i-ii.

Rumberger, R. (1990). In search of evidence. Educational Researcher 18 (4), 55-57.

Shapiro, S. (1990). Between capitalism and democracy: Education policy and the crisis of the welfare state. New York: Bergin and Garvey.

Shor, I. (1986). Culture wars: Schools and society and the conservative restoration, 1969-84. Boston: Routledge and Kegan Paul.

Slaughter, S. (1990). The higher learning and high technology: Dynamics of higher education policy formation. Albany, NY: SUNY Press.

Taylor, R., H. Rosen, and F. Pratzner (Eds.), (1982). Job training for youth: The contributions of the United States employability development system. Ohio State University: National Center for Research in Vocational Education.

Wexler, P. (1987). Social analysis of education: After the new sociology. New York: Routledge and Kegan Paul.

Wilms, W. (1981). The nonsystem of education and training. In P. Doeringer and B. Vermeulen (Eds.), Jobs and Training in the Eighties (pp. 19-49). Boston, MA: Martinus Nijhoff.

Winner, L. (1990). Is there a light under our bushel? Three modest proposals for S.T.S. Bulletin of Science, Technology, and Society 10 (1), 12-16.

Wirth, A. (1980). Education in the technological society: The vocational-liberal studies controversy in the early twentieth century. University Press of America.

EVERYDAY ETHICS IN UNDERGRADUATE LABORATORIES

Linda M. Sweeting,
Department of Chemistry,
Towson State University,
Baltimore, MD 21204

I first began to consider ethical issues in chemistry as a graduate student, when I began to suspect that the chemical industry's reports of clean water and air were probably deceptive and certainly self-serving. When I began teaching, the first ethical issue I had to deal with was safety. I am still concerned about safety, especially since Maryland apparently has no laws governing safety standards for students in University laboratories.

It was not until the early 1980's that I began to be concerned about fraud. Dramatic cases appeared in scientific magazines and newspapers - even painted mice. I began to consider what the roots of fraud were and how I as a teacher could minimize the chance than any of my students would eventually misrepresent their observations. One thing was certain - preaching wouldn't work. The students, like myself, probably spent a lot of their childhood listening to sermons from their parents and other authority figures and are now immune to such rhetoric. I had to find a natural way to incorporate ethical standards into the classroom.

Two aspects of the academic atmosphere that seemed to contribute to fraud I had some hope of changing: the high incidence of (and toleration of) cheating and the overwhelming emphasis on the "right answer". I will discuss cheating in a moment. Imagine you are the student. Throughout your education, the teacher has the "right answer" which you must deduce. In graduate school, the "right answer" is the one your thesis advisor predicted. At work, it is the one your boss wants, or the one that will make you famous or your company profitable. If I could begin to show my students that science is an exploration, where no one has prior knowledge of the "right answer", and begin to impress upon them that any kind of biased or sloppy work threatens all of science, I would make a big difference. If I could stimulate them to be excited about what might be learned from things that go "wrong", I could turn the students into research scientists.

To discourage outright fraud, I raised the penalties for cheating. Students receive an F for the course for any falsification of laboratory results: copying from others, claiming to do work they did not do, misrepresenting the results they obtained. These high standards for student conduct are explained in my syllabus as follows:

> "Because science requires absolute honesty in observation and report, no deliberate misrepresentation of an experiment will be tolerated; fabrication of data will result in a grade of F in the course. Without honesty there is no science - there can be no compromises at any stage."

Actually detecting these misrepresentations probably seems impossible, but it is not. At Towson State, faculty do all of their own teaching -

including supervising and grading laboratory work. I am an active teacher, walking around and chatting with students to see how things are going and prodding them into thinking and observing - and writing their observations down. I warn them that I remember the reactions which don't work and the weird colors - the very things that usually prompt them to ask for my attention in the first place. You may think I have a phenomenal memory. I don't. I have found you only have to remember a few things to impress the students. It is also much easier for me to remember one experiment in twenty than it is for the students, because I have seen the experiments many times before and know both the normal behavior and the pitfalls.

What has been the result of these severe penalties? I have so far failed only one student. He claimed to have done an experiment for which we did not have the reagents. Since I can seldom prove my suspicions as I could in this case, I usually give them a very strict warning, and recommendations for changes in behavior which will allay my suspicions. I wish I had learned these methods earlier!

I have developed several ways to wean students from their fixation on the "right answer". The key to each is grading. No matter what you say about scientific methods, about standards of data collection and reporting, if your grading policy rewards the wrong behavior, you have wasted your time. For example, if I say that their thought processes are important but give credit only for the answer, I have again forced them to focus on the "right answer". If I tell the students to interpret data conservatively and cautiously, and then reward the person who leaps to conclusions and is finished first, caution will disappear, replaced by wild, unsubstantiated speculation. I will let you judge how consistent I have been as I describe some of my methods.

First, I choose experiments which are exploratory, rather than oriented toward an answer. In organic chemistry, this is easy, since most of the experiments are qualitative, such as separations and synthesis. It is possible to obtain a poorer or better yield, but the results are not right or wrong. I resist the temptation to grade on the basis of yield only. Exploratory experiments can be chosen in every course, even those where the students usually determine a numerical value. The students are learning laboratory skills during these courses. I believe in giving them a chance to improve their skills and in giving them credit for their creativity in solving problems. The only "right answer" they ever need is the correct computation from a measured value.

Eventually, though, they will need to be evaluated on their laboratory results. During their undergraduate career, they must develop certain measurement skills in order to do science, and those whose skills are better will obtain more accurate results. The students who develop the skills to solve these controlled problems are ready to work on a real unsolved problem. Traditionally, organic chemistry students are given a compound whose identity is known to the instructor; the students determine the identity of the "unknowns" using the chemicals and equipment available in the laboratory. Here, there is a right answer. Still, I try to remove the focus from the right answer, because not all "unknowns" are equally difficult, nor are all the qualitative tests equally successful for each "unknown". There is no way to provide a grade that reflects the students' knowledge and skill by looking at the answer alone. Thus the grades depend on the thoroughness of the students' experimental work and the logic of their analysis (described in writing); the description in my syllabus is:

> "A: All relevant experiments attempted with complete and logical analysis. Usually the compound will be correctly identified.
> B: One or two missed opportunities for data collection or analysis. Usually the compound will be correctly identified.
> C: Although the compound may be correctly identified, certain important confirmatory tests were not done, or were misinterpreted; conflicting results ignored.
> D: Irrelevant tests and illogical discussion.
> F: Minimal tests not even attempted. Illogical."

Of course, thorough logical work usually results in a correct identification - but not always. Often the students have conflicting data, and are forced to reject certain information as more likely to be erroneous than other information. The choices they make during this data interpretation help to prepare them for the real world temptation to reject data which doesn't conform to their pre-determined, much-loved theory. I would like to find a more explicit way to use these laboratory problems to teach them the dangers of loving their theories too much.

Having chosen the experiments, I require all students to keep a research notebook, a thorough record of everything they do and observe in the laboratory, plus calculations and tentative conclusions. I insist that the notes be written in the laboratory, even if they are a little untidy. Erasures are not permitted, and would be difficult because the students make carbon copies as they work (special notebooks are available). The carbon copies are turned in to me, so that they can continue to work while I am grading. This is hard for the "good" students to accept. They have been conditioned to let the teacher see only neat, sanitized versions; they want to write a formal version at home. If things aren't too hectic, I check the notebooks before they leave. More often, I detect the notes written at home because they are neat, have wording just like the text, and have drawings that correspond to the text rather than the actual apparatus. 60% to 80% of their laboratory grade is determined by these notebooks, by how close they come to my stated ideal, that:

> "You are to treat your laboratory notebook as if it were the only record anywhere of how to do this experiment. Pretend that you are doing research and that no one has ever done this experiment before. The notes you take should be sufficient so that anyone (including yourself 10 years from now) can take your notebook and repeat the experiment using your notes and know exactly what to do and what will happen."

Another 10% of my students' laboratory grade is directly determined by their results, and the remainder by exams, presentations and my evaluation.

Teaching students to keep a research notebook has several consequences. I impress upon them that, if they write down what they do as they go along, they are more likely to write what they actually did rather than what they were supposed to do, and will thus catch errors in procedure before it is "too late". I don't know a single scholar who at some time has not lost important data through carelessness. I hope to save them some of the pain, by showing how to prevent such embarrassing and expensive losses, knowing full well that at some point in their career they will learn the hard way, as I did. I believe that careless errors and omissions contribute much more to weakness in the scientific literature than fraud. In fact many frauds begin as small ones, to cover up careless omissions and procedural errors.

Recording their observations as they do the experiment allows students to observe interesting colors, textures, etc., writing them down without losing their focus on the project at hand. I react enthusiastically to any weird occurrences and interesting observations, encouraging other students to take a look. I hope to ignite some of the sense of wonder they had as children, the excitement about the natural world that drew them to science in the first place. Subtly, this focusses their attention on what is really happening, rather than what is "supposed to happen". Those small observations (smell, for example) often enable them to evaluate the conflicting data they obtain about their unknown compound. It is just this attention to interesting observations made while doing something else that is the source of new ideas in science.

Once again, grading establishes the emphasis. The students' grades are determined primarily by the level of detail in their notebook. They are also graded on their conclusions, by the consistency of their conclusions with their data and their evaluation of the level of certainty of data and conclusions. When they identify an unknown, they are told that it is possible to have the "wrong answer" and get an A, and possible to have the "right answer" and get a C. Again this represents well the situation where no-one knows the right answer". If you are doing research, you collect the data and struggle to interpret it. The care with which you collect your data and interpret it, is the only indication of whether you are right or wrong; the steps you take must be flawless. If you have made your case well, your paper will be published and your work respected. If you are in production, your logic and experiments also need to be flawless. If you turn out to be incorrect, you could lose your job, or cause someone's death.

As I mentioned at the beginning of this talk, I have also struggled with teaching the students safe work habits. I had noticed that the students' eyes tended to glaze over during my weekly presentations of hazards and safe techniques. I decided to give them an active role in safety. Now, each student must make a 5 minute presentation (for credit) of the hazards of the chemicals or apparatus to be worked with for one day's experiment. This activity brings them into contact with safety literature, gives them a sense of ownership of the problem of safety and gives them a chance to speak in public in a reasonably friendly environment. One of the students last semester confessed he had obtained help in finding the information. I took advantage of the opportunity to congratulate the student on his honesty and to talk about the importance in science of giving appropriate credit for assistance and source materials. For the rest of the semester, students' safety presentations and notebooks were full of generous references. I believe this sermon was effective because it grew naturally out of a classroom activity and a student comment. Chance favors the prepared mind.

I believe we all teach ethics in the classroom, whether we plan to or not. Students notice our actions and will ignore what we say if it conflicts with our actions. We teach the students about our values and our ethics by the way we teach them, treat them and grade them. Let's be sure that we teach them what we want them to learn.

COMMUNICATING ENVIRONMENTAL RISK AT THE HIGH SCHOOL/COLLEGE LEVEL: AN S.T.S. SIMULATION APPROACH

James P. Hamilton
Penn State Mont Alto
Campus Drive
Mont Alto, PA 17237

Understanding and communicating the complexities of various forms of risk have always been part of the role of science. Never has that role been more necessary than now. As populations increase, and technology spreads, more and more people find themselves facing and producing risks that were unheard of but a few short years ago. Unlike many of the risks of the past that were reasonably straightforward (will the hanging wall of the coal mine cave in?), many of the risks of today are extremely complex and sometimes subtle. In contrast to the past, the information age has made more people aware of the fact that they may be at risk. Even the most remote home in the United States, for example, can have access, through a satellite dish, to dozens of television channels. Scarcely a day goes by, without a major network news program doing a story on some segment of the population being at risk for some reason. It would seem that many more people are likely aware of the risks they face, but does awareness mean understanding?

It is important for risk managers and communicators to understand how those at risk in the public sector arrive at their perceptions of risk and what factors contribute to the public's ultimate acceptance or rejection of a particular risk. Much has been written about the various (and allegedly objective) means by which "real risk" can be calculated. Objective risk is based on the calculations of so-called experts who plug data into various formulae and models to produce probability statements. The data are supposed to come only from empirical sources and the conclusions arrived at either by direct observation inductively, or by solid inference, deductively. On the surface, this would appear to be sufficient. After all, if you have the facts, all that remains is to find some appropriate means by which to transmit those facts to the necessary people and all should be well. There is ample evidence that this is not so.

In the first place, even the experts cannot agree on an objective assessment of risk. For example, Covello (1989) cites a number of examples.

> a study by a committee of the National Academy of Sciences estimated that the expected number of bladder cancers resulting from the consumption of saccharin over a lifetime of exposure ranged between .22 and 1,444,000 cases, depending on the particular assumptions that were made (National Research Council, 1978).
>
> a study by the U.S. Nuclear Regulatory Commission estimated that the risk of a core-melt at a nuclear power plant ranged between 1 chance in 10,000 to 1 chance in 1,000,000 depending on the assumptions that were made (Nuclear Regulatory Commission, 1987).
>
> a set of studies commissioned by the city of Oxnard, California and by industry estimated that the risk of an explosion at a liquified natural gas plant proposed for Oxnard ranged between 10^{-3} and 10^{-50}, depending on the assumptions that were made (Lathrop and Linnerooth, 1982).

Experts often see technological choices in different, sometimes contradictory, ways even when the information is not at question. And if these disagreements among experts were not enough, still another set of circumstances creates risk communication difficulties.

No one who is at risk ever views risk in a vacuum, devoid of emotion. It simply cannot be done. Often the recipients of the message not only do not understand, if they do understand, they do not agree with the communicated level of risk. Sometimes it is a matter of disagreeing with the manner by which risk has been determined, a problem already seen to exist among experts. But perhaps the greatest of difficulties for the risk communicator is trying to understand how all of the subjective elements of a risk situation interact with the scientifically derived elements to create the final perception of risk for those not in the scientific community. A number of environmental factors have been identified that have an impact on the ways in which those at risk come to perceive risk.

One of the factors affecting the perception of risk has been what Lipset and Schneider (1987) have identified as a significant reduction in the trust afforded business, labor, and the government over the last thirty years, often the very people trying to communicate risk. This coupled with some very public disagreements between experts makes for an understandably skeptical public.

Covello (1989) provides a compilation of additional factors that numerous studies have found affect the perception of risk (Vlek and Stallen, 1981; Renn, 1981; Otway and von Winterfeldt, 1982; Covello, 1983; Janz and Becker, 1984; Slovic, 1987). Covello (1989) states that people are more frightened of risks that:

are based on human rather than animal studies.
are concentrated in time and space.
are from unfamiliar circumstances.
are scientifically uncertain.
are not under personal control.
are involuntary (such as toxic dumps) not voluntary (such as smoking).
put children specifically at risk.
put future generations at risk.
concern identifiable victims rather than just statistical victims.
evoke dread or terror rather than common feelings such as household accidents might cause.
derive from low credibility institutions.
receive much media attention.
derive from activities that have a history of major accidents.
derive from what is perceived as an inequitable distribution of risks.
appear to have unclear or questionable benefits.
seem to be irreversible.
place them or their families personally in danger.
derive from human origins rather than acts of God or nature.

The tendency to respond emotionally and to have inaccurate perceptions (as compared to objective measures) of risk is well documented. Tversky and Kahneman (1973) found that people tend to assign a higher probability to things that come easily to mind. Lichtenstein, Slovic, Fischoff, Layman, and Combs (1978) determined that people tended to overestimate low risks, particularly if they were of a violent nature, while underestimating high risks, usually the nondramatic types. Other studies support conclusions that can be drawn from casual observation. People tend to ignore information about risk if it is contrary to already held beliefs (Nesbett and Ross, 1980). People dislike uncertainty and would rather be told absolutes than probabilities. They also are not interested in risk data for society but rather prefer data that are specifically relevant only to them. And, of course, the "it can't happen to me" phenomenon, particularly for activities involving personal skill, is very well documented. Covello (1989) points out that studies show that fully 95% of all drivers think that they are above average drivers.

So what are we to do? How can we arrive at the means by which to communicate risk effectively given all of the elements that seem to get in the way? Perhaps one of the answers is to try to understand the circumstances within which the various publics develop their perceptions of risk. Complete meaning ultimately lies in people, not in symbols such as words. Of course there is some meaning in words, otherwise we would not be able to function as a society. But true meaning goes beyond the denotative, dictionary definition. True meaning for a symbol usually conjures up an image in the mind of the user, and that image varies in strength. Additionally, there are nearly always emotions attached to that image and those emotions also vary in strength. Ultimately, the true and complete meaning of a symbol for an individual includes image/strength of image and feeling/strength of feeling.

These images and feelings must, of necessity, come from the memories of past experiences, a perceptual frame-of-reference, as filtered through a particular sensory mechanism. Since no two people can ever have exactly the same combination of experiences and sensory mechanism, no two people can ever have precisely the same perceptual frame-of-reference, and hence meaning, for a set of symbols. While exact duplication of meaning is impossible, there are certainly strategies available for being better understood. Primary among these strategies is systematically assessing the audiences to get a sense of the collective perceptual frame-of-reference. There is not a public speaking text to be found that does not have at least a chapter on audience analysis.

There are a variety of means by which to gain some understanding of the perceptual frames-of-reference of your audiences. For example, one can study demographics and make inferences. One can simply ask, either directly or by questionnaire. Or one can study the studies that have been done on audiences like yours. But none of these approaches will give the communicator much information about what it is like to be a member of the group with whom he or she wishes to communicate. Remember, complete meaning involves the affective domain. If you do not have a sense of the emotional attachment of the audience to the topic, you have an incomplete analysis.

Perhaps the least used, but one of the most effective means by which to prepare for risk communication is through role playing simulations. Complex, multi-role Science, Technology, and Society-type simulations have been used to teach environmental risk assessment and communication for fifteen years in a program called the Pennsylvania Conservation Leadership Schools.

The Conservation Leadership Schools are statewide two-week resident conservation/environmental education programs for high school/college freshman-aged students. Many students take leadership roles in their local communities often as staff members in county level conservation schools. It is important for students not only to understand how to assess risk in a variety of conservation/environmental/resource management circumstances but also to gain skills in communicating risk to a variety of audiences. The CLS students may be teaching risk assessment to other students at some point and they may also be trying to communicate about risk in a public forum. Many CLS students organize or are involved in environmental groups in their home towns. They occasionally find themselves testifying at public hearings and the like. Indeed, one of the major goals of the CLS is to prepare students for and encourage them to become active in the representative democracy that governs this nation. To this end, we felt that students should be exposed to the multitude of factors that create the total perception of risk.

Unlike so much of education, STS is an integrative, rather than reductionist enterprise. It is ideally suited to a more comprehensive understanding of risk, particularly environmentally related risk. Environmental problems are often the result of the cumulative effects of the behaviors of millions of people, and those behaviors are influenced by social, economic, theological, educational, psychological, scientific, health and other factors. Therefore any effort to understand the nature of risk, and more specifically to communicate it, requires that all of its dimensions be considered. There are essentially two ways in which elements of risk have been included in the Conservation Leadership Schools curriculum.

The first type of simulation usually involves problem solving in a resource management scenario. Students are asked to make decisions about how a particular resource ought best to be managed (or not managed, as the case may be). There are a variety of risks (such as, economic, health, or ecological risk) involved. The ultimate management decisions are based, in part, on the extent to which these various risks interact and have long- or short-term impacts. And, of course, the extent to which risk of various types appear depends upon the management decisions made. The second type of simulation is one in which there are clear risks described and students are asked to assess and respond to these risks. Their goals are to understand the perceptions of risk within the roles they are asked to play.

An example of the first type of simulation is a unit on diversity. As a part of the unit, students are placed into groups of eight in a farming simulation. They are given a prescribed amount of land and specific crops to plant. They may either plant one crop or they may plant four different crops, and having once been assigned a crop or crops, they must stay with that plan for the duration of the simulation. There are different risks involved depending on whether they choose monoculture or diversity. Each group must also make choices about the use of pesticides, fungicides, fertilizers, the type of equipment they will use, and so on, and there are different risks involved in all of those choices as well. The simulation lasts for ten theoretical years. At the end of each year there are yield reports and crop prices given to the students. From these they can calculate their profits or losses and then make the choices for the following year. After ten years, each group determines its financial status and is compared with all of the other groups. Characteristically, there are differences between monocultures and diverse crops, between organic and traditional practices, and between various types of equipment strategies. Each combination of management choices has its own set of risks. Simulations of this sort are , of course, designed to teach about various types of risks and the means by which to assess them. The second type of simulation not only teaches these but also communicates something quite apart from simple risk assessment.

The type two simulation helps students assess how people arrive at their perceptions of risk; this in preparation for becoming better risk communicators themselves. The simulation is such that participants are asked to play the roles of those at risk. Built into the simulation are many of the factors known to affect how those at risk ultimately come to perceive risk. Included are children and future generations, differing levels of personal risk, involuntary risk, differing levels of benefit, identifiable victims, institutional credibility, and inequitable distribution of risks, to name a few. Different roles ask participants to assess risk according to different importance criteria. Additionally, participants are asked to assess scientific risk from the perspective of their roles. The combination of scientific risk and importance constitute total perceived risk. The complete

Conservation Leadership School Environmental Risk Assessment Unit is included in Appendix A.

Both types of simulations provide unique combinations of experiences. The simulations are integrative rather than reductionist. Far from narrowing the circumstance to a limited view of risk, they broaden the perspective to include, economics, ecology, theology, psychology, sociology, and personal lifestyle. STS simulations of this type require that students function at the highest levels of Bloom's taxonomy. They often involve counter-attitudinal advocacy in which students are asked to argue from perspectives not their own. In this way, they are forced to try to understand the perceptual frames-of-reference of others, an essential step if they are to communicate risk effectively.

Risk assessors and communicators that do not take into account the non-scientific factors affecting the perceptions of those at risk must, of necessity, fail. Simulations like those described here are one way to prepare for a better understanding of the multidimensionality of risk. No single simulation can prepare one for all risk circumstances and this speaks to the need for continued development of STS-type risk simulations involving a wide variety of scenarios. Much more work needs to be done in the development and testing of STS simulations.

For a complete copy of the Conservation Leadership Schools Diversity Unit, Master Plan Unit, or Public Hearing Unit, contact Dr. James P. Hamilton, Penn State Mont Alto, Campus Drive, Mont Alto, PA 17237.

References

Covello, V. T. (1989). Informing people about risks from chemicals, radiation, and other toxic substances: A review of obstacles to public understanding and effective risk communication. In W. Leiss (Ed.), Prospects and problems in risk communication. (pp. 1-25). Waterloo, ONT: University of Waterloo Press.

Covello, V. T. (1983). The perception of technological risks: A literature review. Technological Forecasting and Social Change, 10 (2), 285-297.

Janz, N.K. & Becker, M.H. (1984). The health belief model: A decade later. Health Education Quarterly, 11, 1-48.

Lathrop, J. & Linnerooth, J. (1982). The role of risk assessment in a political decision process. In P. Humphreys & A. Vari (Eds), Analyzing and aiding decision processes. Amsterdam, North-Holland.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., & Coombs, B., (1978). Judged frequency of lethal events. Journal of Experimental Psychology: Human Learning and Memory, 4, 551-578.

Lipset, S. M. & Schneider, W. (1987). The confidence gap, business, labor, and government in the public mind. Baltimore: Johns Hopkins University Press.

National Research Council (1983). Risk analysis in the Federal government: Managing the process. Washington, DC: National Academy Press.

Nesbett, R.E. & Ross, L.D. (1980). Human interference: Strategies and short comings of social judgment. Englewood Cliffs, N.J.: Prentice Hall.

Nuclear Regulatory Commission (1987). Reactor risk reference document. (NUREG - 1150, Vol. 1), Washington, DC: U.S. Nuclear Regulatory Commission.

Otway, H. J. & von Winterfeldt, D. (1982). Beyond acceptable risk: On the social acceptability of technologies. Policy Sciences, 8, 127-152.

Renn, O. (1981). Man, technology, and risk: A study on initiative risk assessment and attitudes towards nuclear power. (Report Jul - Spez 115). Julich, German Federal Republic: National Research Center.

Slovic, P. (1987). Perception of risk. Social Science, 236 (4799), 280-285.

Tversky, A. & Rahneman, D. (1981). Judgement under uncertainty: Heuristics and biases. Science, 211, 1453-1458.

Vlek, C., & Stallen, D. J. (1981). Judging risks and benefits in the small and in the large. Organizational Behavior and Human Performance, 28, 235-271.

Appendix A

Conservation Leadership School Environmental Risk Assessment Unit 1990

Assessing risk is a complicated and difficult task. There are no exact answers. First of all, what is risk? It is danger or potential harm to something. It is desirable, in environmental cases, to reduce risk if possible. If there is risk to something, that risk can usually be assessed relative to other sorts of risk. What makes the assessment of risk so tricky is that there are really two things going on. The first is that there is a danger present that must be calculated somehow. The second is that the thing being put at risk has different degrees of importance to different people which makes things much more complicated. One thing we must get straight right away: THERE IS NO SUCH THING AS ZERO RISK....EVER!

Let me give you an example. What is the only safe speed for a car? You might say zero miles per hour. How can there be any danger if the car is not running and you are nowhere near it? Well, suppose you have decided not to ride in cars anymore and you have just cut yourself badly and will bleed to death if you don't get to a hospital. There are no ambulances where you live, only a car. Now is there no risk by keeping the car at zero miles per hour?

Another funny thing about reducing risk is that the further you go, the more expensive it gets. For example, you can build an airplane that is...say...95% safe for $20 million. To make it 96% safe might cost $30 million. To make it 96.5% safe would cost $40 million. At 97%, it costs $60 million and so on. Pretty soon, you can't build airplanes anymore, and you could NEVER MAKE IT 100% SAFE.

Now let's get back to that thing about assessing risk versus how important things are to people. Scientists like to be very objective and use the scientific method when investigating a problem, and they should. For example, they might want to assess the risk of some substance purely on the basis of how many parts per million (ppm) will cause liver damage in rats over three months. And that is absolutely vital information to have. It is the kind of information that many people don't bother to get before they run off half cocked, screaming and yelling like some three year old, about an imaginary threat they don't really understand. So one of your problems as an environmentalist is to try to understand risk, threat, or danger from the scientific point of view, and to help others understand it better too. But there's that whole thing about importance that keeps cropping up. Scientists don't often pay attention to it, but environmentalists cannot afford to ignore its importance.

Let me give you an example of how this works to create a dilemma for us. Let's suppose there is a substance called polybrominatedpizzasauce (pbps for short) that causes several problems if it gets into the air. First, it causes about three children (age 1 - 5) in 100,000 to get laughingobia. They laugh so much that they cannot eat, sleep or drink and they die. It also kills 100% of the honeybees at the same concentration. If you asked people to tell you how much of a risk they PERCEIVED pbps to be, wouldn't it depend on whom you asked? Isn't the PERCEIVED IMPORTANCE OF WHAT'S AT RISK the fly in the ointment? If you asked a group of parents who had children ages 1 - 5, and lived near the pbps to tell you how important the loss of three children in 100,000 is on a scale of 1 to 10, they might say ten. If you asked them to tell you how important the loss of all of the bees is, they might say three. Particularly if they don't understand the importance of bees in pollinating thousands of species of plants. If you asked an orchard owner to talk about importance, she/he might say the loss of 3/100,000 children is an eight, while the loss of all of the honeybees is a ten.

There are many ways of looking scientifically at the risk in this example. Three in 100,000 is .003% risk for children, while for the honeybees it is 100%. On a scale of 1 to 10, how important to the health of the planet is the loss of three in 100,000 children? How important is the loss of 100% of the honeybees? Is human life sacred? Is honeybee life sacred? Is all life sacred? You see the dilemma by now I hope. It is social, theological (religious), economic, ecological, a matter of health, quality of life and much more. Different people will see it differently, and that is why it is so very hard to communicate with people about risk. You see, your values and theirs, what you think is important and what they think is important, are probably different.

We are going to ask you to play a little game of risk assessment with us. You will be given the role of a special interest group and you will be given a situation, and some evaluative criteria. You will be asked to rate the importance of the criteria on a scale of 1 to 10. In other words, which of the ways of looking at the situation are most important to you? You will then be asked to analyze some data and to rate the scientific risk on a scale of 1 to 10 also. This is not how scientific risk is decided but it will simplify things for our purposes. You will then multiply the number you gave the criteria for importance by the number you used to represent risk for each area. The total of all of these products will be your total PERCEIVED RISK score.

The Situation

The Elementary School for the area is 200 yards down wind of the Electrobotics plant. There are about five hundred students at the school and the school gets its water from the well field mentioned.

There is definitely dinitrochickenwire (DNC) in the ground water on the electrobotics property. None has been found in any of the wells off the Electrobotics property yet. It has also been found to be present more or less daily in the air for five miles down wind of the plant (East), and one half mile west of the plant. There is DNC present in the Smith River.

The concentrations of DNC are as follows:

Electrobotics ground-water	20 ppm
Air in Utopia	3 ppm
Air in Development	5 ppm
Air outside the Elementary School	5 ppm
Air inside Elementary School	3 ppm
Smith River	5 ppm
Fish in Smith River	10 ppm
Insects within one mile of plant	3 ppm
Wells in well field	0 ppm
Air in the plant	7 ppm

DNC has been found to have the following properties:

1. It is a biological magnifier. As it goes up the food chain, the concentrations get higher.

2. It has been found to cause all birds to lay eggs with thin shells (just like DDT) if they eat concentrations over 10 ppm.

3. It is the best and cheapest solvent available for Electrobotics.

4. It has never been shown to cause death in humans but it causes a number of health problems.

a. It is more toxic to children under the age of 13 than to adults and causes stunted growth, rashes, and lack of ability to pay attention when in concentrations of 5 ppm. This usually happens in about 1 in 100 people. It will do the same in adults if over 7 ppm.

b. It causes liver and kidney damage in rats in concentrations of 10 ppm but the link to humans has not been established.

c. There have been reports of rare but severe allergic reactions to DNC at concentrations of less than 3 ppm in both children and adults. About 1 in 100,000.

5. Once it is in the food chain, it takes 50 years to work its way out.

It will cost the Electrobotics company $50,000 per year for ten years to clean up the DNC and to upgrade their treatment if they decide to use DNC in the future. It will cost $25,000 per year for ten years just to clean up the DNC. However, it will cost an additional $50,000 a year to use a more expensive but safer chemical.

Doing nothing means that the company will remain competitive and no jobs will be lost. Cleaning it up and upgrading the safety systems to continue using DNC means that the company will break even every year unless they lay off some employees (each employee layed off means $5,000 in additional profits). However, the potential for an accidental spill is about 1 in 1000. Cleaning up and going to a safer chemical means that , to break even, they will have to lay off at least five people. To get their old profits back will mean laying off fifteen people minimum.

Cleaning the air inside the school (if nothing is done at the plant) to 0 ppm will cost $100,000. Cleaning the air inside a home to 0 ppm costs about $1000 per home.

Background on the Case .
(adapted from EPA simulation)

The Company

Electrobotics was formed 15 years ago as a privately held company that manufactures electronic components for the computer industry. Electrobotics has had a rocky history and has been close to bankruptcy several times. However, recently its performance has improved and it now has revenues of $7.5 million, though after-tax profits are only $50,000 per year. It employs 150 people and has a reputation for treating its employees well. It has never laid off an employee, even when times were tough.

Location

Electrobotics is situated in a sparsely populated area. A residential development of 80 people and 20 houses was recently built 1/2 mile from the western property line. Additionally, Utopia lies a little more than 1 mile east of the company. Utopia relies on ground water from 40 wells for its water. The wells supply 50,000 people including those west of Electrobotics. Groundwater flows from Electrobotics towards the wells, but estimates are that only three of the wells would likely be affected by groundwater contamination coming from Electrobotics. (SEE MAP) There is an elementary school only 200 yards east of the Electrobotics property line.

Problem

About five years ago, Electrobotics changed production processes such that they needed to use an industrial solvent call dinitrochickenwire (DNC). Wastewater containing the solvent is stored in a flow equalization lagoon that is part of the Electrobotics wastewater treatment plant (see map). After treatment, the water is discharged into the Smith River. An activated sludge process is used.

Roles

1. You are residents of Utopia who work in the Electrobotics plant. You also have children who go to school in the Elementary school located near Electrobotics. You must try to understand what things are important to your group of people as you assess the perceived risks of the situation.
2. You are residents of Utopia who do not work for Electrobotics. You also have children who attend the elementary school.
3. You are the owners of the company. You do not live anywhere near the Electrobotics plant; you have no small children, indeed, you have no relatives living in the area.
4. You are commercial fisherpersons who catch fish in the Smith River. The river has been a viable freshwater fishery for many years, carefully managed to prevent overharvesting. Your entire living comes from the river and has for generations.
5. You are employees of the plant but you do not live in any affected areas and you have no children going to school in the affected areas.
6. You live in the housing development, do not work in the plant, and your children are grown and gone. You are retired and on fixed income. Your property is your guarantee of money for the future. Your plan has always been to sell it and use the money to move South.

CRITERIA:

ON A SCALE OF 1 TO 10, HOW IMPORTANT ARE EACH OF THESE THINGS TO YOUR GROUP?

ALSO, ON A SCALE OF 1 TO 10, HOW MUCH RISK OR THREAT OR DANGER DO YOU THINK THE FACTS INDICATE FOR EACH ITEM?

1. How important is the health of the children?____________________________
   A. Danger to the health of the children if we do nothing?____________________
   B. If clean-up, new safety measures, and continue DNC?____________________
   C. If clean-up and use safer product?________________________________
   A. Perceived risk = importance score x risk score________________________
   B. Perceived risk = imp. x risk ___________________________________
   C. Perceived risk ____

2. How important is the health of the workers?____________________________
   A. Danger to the health of the workers of doing nothing?____________________
   B. Of clean-up, upgrade, and continue DNC?__________________________
   C. Of clean-up and use safer product? ______________________________
   A. Perceived risk = importance x risk ______________________________

B. Perceived risk ________
C. Perceived risk ________

3. How important is job security at the plant? ________
   A. How much risk to job sec. if no clean up? ________
   B. If clean-up and continue to use DNC? ________
   C. If clean-up and use safer product? ________
   Perceived risk = imp. x risk A. ________
   Perceived risk B. ________
   Perceived risk C. ________

4. How important are company profits to you? ________
   A. How much risk is there to company profits of no clean-up? ________
   B. of clean-up and continuing to use DNC? ________
   C. of clean-up and using safer product? ________
   Perceived risk A. ________
   Perceived risk B. ________
   Perceived risk C. ________

5. How important is the health of the people in the development? ________
   A. What risk to their health of doing nothing? ________
   B. Clean-up and continue DNC? ________
   C. Clean-up and safe product? ________
   Perceived risk of A. ________
   Perceived risk of B. ________
   Perceived risk of C. ________

6. How important is the health of the people in Utopia? ________
   A. What risk to these people of doing nothing? ________
   B. Clean-up and continue DNC? ________
   C. Clean-up and safe product? ________
   Perceived risk of A. ________
   Perceived risk of B. ________
   Perceived risk of C. ________

7. How important is clean drinking water? ________
   A. Risk to drinking water of doing nothing? ________
   B. Risk of doing clean-up, upgrade, and still using DNC? ________
   C. Risk of clean-up and using safe product? ________
   Perceived risk A. ________
   Perceived risk B. ________
   Perceived risk C. ________

8. How important is a clean Smith River to you? ________
   A. Risk to Smith River of doing nothing? ________
   B. Of clean-up, upgrade and using DNC? ________
   C. Of clean-up and using safe product? ________
   Perceived risk A. ________
   Perceived risk B. ________
   Perceived risk C. ________

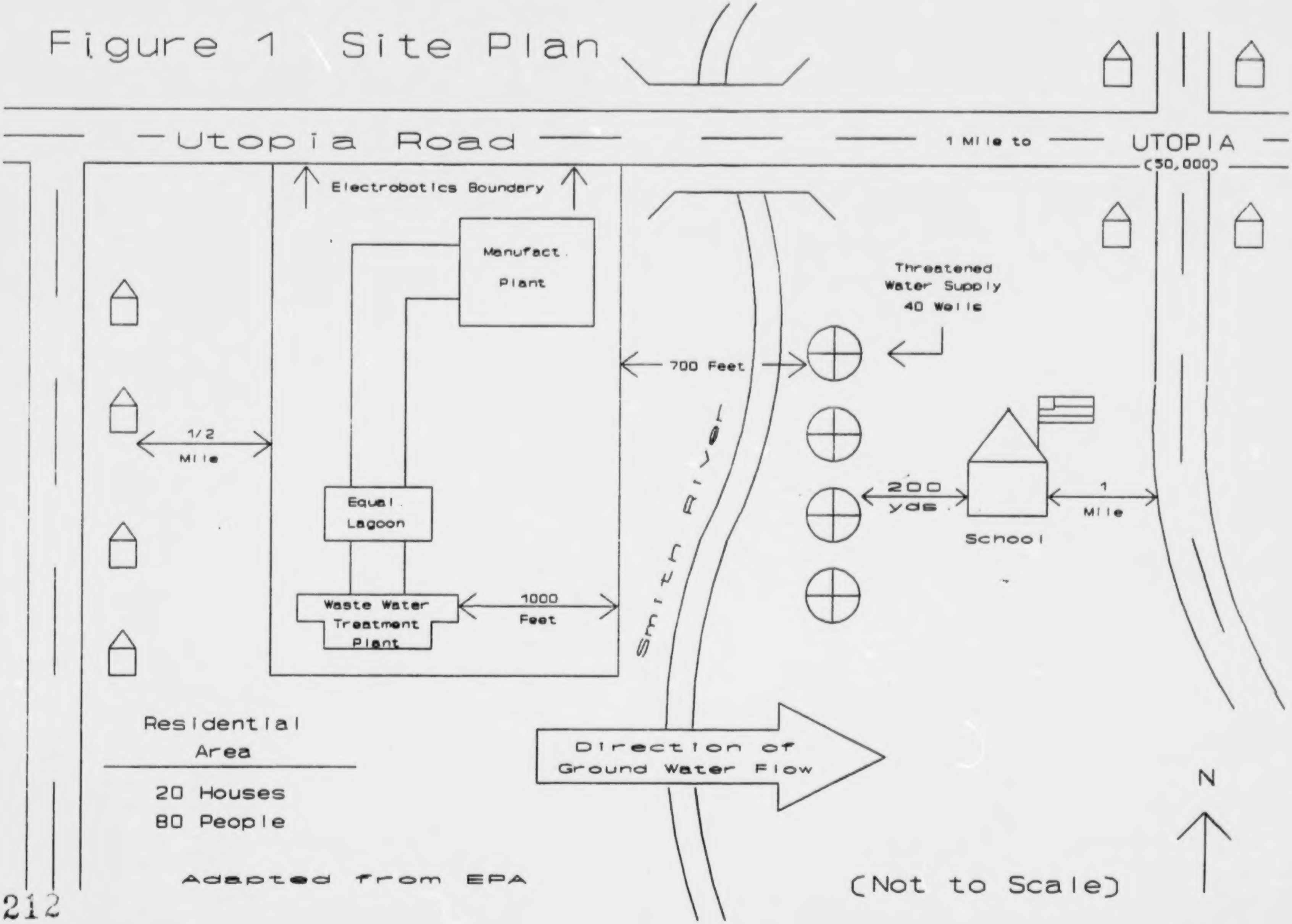
9. How important is it to have a healthy bird population? ________
   A. Risk to birds of doing nothing? ________
   B. Of clean-up, upgrade and using DNC? ________
   C. Of clean-up and using safe product? ________
   Perceived risk A. ________
   Perceived risk B. ________
   Perceived risk C. ________

10. How important are well educated children? ______________________
   A. What is risk to education of children if we do nothing? ____________
   B. If clean-up, upgrade and use DNC? ______________________
   C. If clean-up and use safe product? ______________________
   Perceived risk of A. ______________________
   Perceived risk of B. ______________________
   Perceived risk of C. ______________________

Add up all of your perceived risk scores of doing nothing ______________
Add up all of your perceived risk scores of cleaning up, upgrading the facilities, and continuing to use DNC. ______________________
Add up all of the perceived risk scores of cleaning up and then using a safer but more expensive product.
____

The lowest of these scores indicates the option that your group considers to be the least risky (from your perspective) of the three solutions offered. What do you think contributed most to your group's choice? Was it the importance of certain criteria? Was it strong scientific evidence of risk? If you were in another of the groups would you have made different choices? If you could have done this by yourself, would your choices have been different? Do you see how complicated risk assessment can be? Maybe the real perceived risk is the average of all of the group perceived risk scores.

Figure 1 Site Plan


Utopia Road
1 Mile to
UTOPIA
(50,000)
Electrobotics Boundary
Manufact.
Plant
Threatened
Water Supply
40 Wells
700 Feet
1/2
Mile
Equal.
Lagoon
Waste Water
Treatment
Plant
1000
Feet
Smith River
200
yds.
School
1
Mile
Residential
Area
20 Houses
80 People
Direction of
Ground Water Flow
N
(Not to Scale)

Adapted from EPA

RESTRUCTURING ELEMENTARY SCHOOL SCIENCE IN-SERVICE EDUCATION FOR IMPROVED TEACHING AND LEARNING

Jack Rhoton
Assistant Professor of Science Education
East Tennessee State University
Department of Curriculum and Instruction
P. O. Box 23030A
Johnson City, TN 37614
(615) 929-4288

Finding better ways to improve teaching practices is an ongoing area of concern in elementary school science. Typically, teachers of science in elementary schools have taken the minimal amount of science during their college experience (AAAS, 1989). To camouflage their uneasiness about science, elementary teachers have hidden behind a textbook driven curriculum that has focused on drill activities which stresses traditional lectures and memorization of facts.

Change must be set in motion to allow elementary school science to be implemented in a quality fashion. Pre-service teachers must be better prepared than are most at present. However, because of the weak background of most elementary teachers and their lack of expertise in science instruction, it is essential that science in-service education programs provide for more effective science in the elementary school curriculum.

Curriculum revisions in support of science instruction during the decades of the 1960's and 70's were centered around federally funded projects. The NSF funded curriculum projects were directed by scientists, and did not consider the involvement of classroom teachers in the instructional task. The implementation of these curriculum developments were not very successful because they lacked appropriate teacher training.

Teachers must be directly involved in the decisions pertaining to the instructional process if substantive and lasting change is to occur (Hall et al., 1975). Maximizing the involvement of teacher involvement can be obtained through the use of peer support in in-service education programs. Teachers have experienced the concerns of their peers and understand their day to day problems. Haller (1968) found that teachers rely upon their peers as role models for change. Sergiovanni and Elliot (1975) further demonstrated that peers respect the judgement of their fellow teachers who have successfully implemented instructional activities in their classrooms.

However, most teacher in-service programs have not involved the role of peers in instructional training. Teachers have typically perceived in-service education as ineffective, poorly planned and lacking in personal relationships to the life of their classroom (Harris and Bessent, 1969; Gall, Haisely, Baker, and Perez, 1984). Additionally, the importance of the leadership role of the principal to support intended changes is well documented. Carlson (1965) has demonstrated the success or failure of efforts to improve science teaching is closely linked to the commitment and support provided by the school administrator. Not only do teachers need the commitment and support of their peers and principals, they need help with improved techniques that increase their understanding of science and their ability to translate that knowledge to classroom practices.

A Solution

East Tennessee State University has established a collaborative relationship with the National Science Foundation, local school districts, and the Tennessee Department of Education to develop a model of in-service education for elementary science teachers and principals. The model (Figure 1) is designed to prepare teachers and principals for leadership roles in the improvement of elementary school science. The model accommodates three-member teams from elementary schools in Northeast Tennessee. A team is composed of a primary teacher (K-3), an intermediate grade teacher (4-6), and their principal. Sixty teachers and thirty principals have been trained in the program. The model allows teachers to have control over their own needs. It consists of the following components: teacher-centered in-service institutes, leader teacher training for working with peer teachers, principals training in elementary school science, and university faculty involvement. Each of these components is described below:

Institutes

A six-week institute is typically held during the summer months. The mode of delivery during the intense summer institute consists of seminars and structured hands-on science in-service workshops. The workshops focus on both subject matter content and pedagogy to produce leader teachers and principals who are well trained in content and methodology. The appropriate usage of technologies such as computers, materials, and activities for teaching elementary school science is interwoven throughout the in-service workshops. As the participants increase their knowledge of content and teaching strategies, they enrich the depth of their experience by exchanging, exploring and reacting among themselves.

Each week of the workshops is developed around a theme that has been selected by the participants. Both the teachers and principals engage in laboratory activities and demonstrations appropriate for a particular grade level(s). As part of these activities, visiting academicians and science educators develop participating teachers' and principals' requisite content knowledge, methodologies, teaching strategies and leadership skills for working with peers. At the close of each week's in-service workshop, teachers develop curricular materials appropriate for their science curriculum.

Training Participants to Work with Peers

One of the critical practices of collegiality is observing and being observed by other peers. A portion of each summer institute is devoted to training participants to work with teachers back at their home schools and other schools in the Education Service Center. This training equips participants (both teachers and principals) with skills basic to working with their peers - data collection, observation, peer teaching, non-evaluative feedback, and preparing participants to schedule and coordinate peer activities (Leggett and Hoyle, 1986). Inherent in the in-service model's design is the development of a collegial relationship that has formed the nucleus for a powerful network of elementary science leaders who are providing professional service to school districts in Northeast Tennessee.

Principal's Role

Study after study has affirmed the role of the principal as instructional leader. Leadership occurs where the principal understands the needs of the school and is actively involved in the school's work. The principals go through the same training as do teachers during the summer institutes. The model prepares teachers to work together, rather then perpetuating isolation. It allows for teachers to visit other classes, participate in training sessions, and teach cooperatively. It is for this reason that the principal is an integral part of the program. Principals are trained to make those structural changes that include physical space facilities and schedule changes to make it possible for teachers to effectively implement the science curriculum.

School Visits by University Faculty

University faculty provide on-going support for participants during the academic year through monthly school site visits. These visits allow university faculty to gather information from teachers and principals and to provide support to participants as they implement the in-service model. During the school visits, model lessons are presented so that participants will be continuously aware of the high regard which the project holds for the participants. Visits, however, do not provide the continuous networking inherent in the in-service model design; that is the function of the in-service model. As described below, the project is allowing participants to develop a networking force for improving elementary science education throughout the region.

The model allows for several kinds of communication and networking between and among peer teachers, both within their school and other schools in the district. The participants play the role of sensitive facilitators to establish a climate in which the team members build mutual trust and share what they have done in their classrooms. The project allows for participants to network with their peers in the following ways:

- Leader teachers and peer teachers are granted a minimum of one hour release time each week throughout the academic year to discuss and share information and classroom feedback. At this time, leader teachers may elect to discuss content and methodologies, or reflect on classroom events of that week. These meetings are also used by leader teachers to share information from the summer institute with the peer teachers.

- Peer teachers observe leader teachers teaching a science lesson once a month using the methodologies and content gained in the summer institute. During their weekly meetings, both groups share with each other feedback from the lesson and reflect upon the appraisal of the lesson taught by the leader teacher.

- Leader teachers observe peer teachers teaching a science lesson once a month. These sessions provide insight, solutions to problems, and support and encouragement to one another. Team members receive a great deal of input from one another and benefit from sharing of ideas from their own classroom experience. (Local school districts provide substitute teachers for peer and leader teachers while they are teaching and being observed.)

- Leader teachers lead science in-service and staff development sessions with peer teachers four times during the school year (two days of in-service time already in place and two additional days of release time granted by the school district).

- Leader teachers and principals meet with other schools within their school district two days per year. These sessions are designed to provide guidance for peer teachers in both classroom and laboratory setting.

- Leader principals meet with their faculty each month to provide information and resources concerning science teaching and learning and to prevent barriers that impede effective science teaching.

Major features of the project have been the personal renewal of teacher's expertise in elementary school science content and methodology; the ability to organize and conduct science workshops; the ability to work with peers, and mastery of skills in analyzing and selecting appropriate curriculum and instructional materials for the classroom.

Outcomes

An important outcome of the project has been the "ripple effect." To systematically track and document change, a log is completed and turned in by each of the twenty teams to the project staff each month. These reports include information such as the number of lessons taught, time spent on science, topic presented both in classroom and in meeting with peers, problems, needs, and so forth. These data revealed the following outcomes for participating schools:

- Increased time in elementary school science equal to the recommendations of the National Science Teachers Association.
- In-service teacher training occurring concurrently with science curricular revisions.
- Planned and systematic scheduling of science in-service for each school.
- Significant increases in funding by local school districts to purchase science supplies and equipment.
- Development and implementation of a science laboratory (science room in each school).
- Development and implementation of schoolwide science fair in each school.
- Networking of leader teachers and peer teachers; i.e., leader teachers visiting peer teachers' classroom once per month and peer teachers visiting leader teachers' classroom once per month.
- Shared teacher prepared support materials in support of elementary school science.
- Networking of principals with teachers and other principals both within and outside the school district.

Local school support for elementary school science increased throughout the duration of the project. Although initial activity for many external funded programs are followed by declining enthusiasm, this has not been the case for participating schools represented in the project. This is due primarily to the widespread support of the project from the local school superintendents to the peer teachers. Also, the team concept, including the principal, has been a prime ingredient in the continuous success of the project. Local school districts have committed resources for the continuation of the project so that it will effect the same programmatic changes that accompanied initial phases of the project.

Participant and Student Evaluation

Various data collection instruments have been used to determine if both participants and their students grew significantly in science content and attitudinal perceptions. Figure 2 represents the program evaluation design. A component of the evaluation model was to determine if participants grew significantly in academic science content knowledge as a result of the program. A science test was constructed which contained 90 items that were directly related to the content objectives of the summer institute. Efforts were made to include a good balance of items over the content fields as well as items from both low and high cognitive levels. At the beginning of the institute the participants scored an average of 44.08 percent on the test and at the end of the six week institute they scored an average of 63.00 percent on the examination, a gain of approximately 19 percent. The results from a correlated t-test indicated a value of 13.66, statistically significant at the 0.001 level. The growth of participants achievement was very positive.

A 70 item attitudinal assessment which uses the Likert Scale was administered to participants both as a pretest and a posttest. A correlated t-test was used to determine if the mean for the pretest differed significantly at the 0.05 level of measurement from the mean for the posttest. Significant gains in attitudes toward science and science teaching were discovered among the participants.

An effective assessment (Semantic Differential Technique) was developed and administered to participants both as a pretest and a posttest instrument. Results from the data were analyzed using a correlated t-test procedure. This test determined whether changes in means from the pretest to the posttest were statistically significant. The results indicate statistical significance when the probability level was 0.05 or smaller. All significant results were rounded to 0.05, 0.01, or 0.001 for reporting purposes.

A scale of attitudinal assessment which ranged from highest (excellent = 16-20) to lowest (poor = 1-5) was administered at the close of the institute. All participants rated the program excellent with the average being 18.11 and the standard deviation 1.10. These data indicate an excellent rating for the institute program.

With the conclusion of the project, ETSU had sufficient data base for an initial assessment of the effectiveness of the program and student learning. Data were collected from 41 elementary classrooms to compare the performance of students taught by the leader teachers with that of students taught by other teachers in similar situations in non-participating districts. Significant improvements ($p < .01$) in general student performance were observed in leader-taught classes.

Summary

The project has brought about a restructuring of the system as it pertains to planning and implementation of elementary school science. The thirty three-member teams represent a "high powered" network of teachers and principals specifically prepared to change the way elementary school science is delivered. The principal has been a prime ingredient in the team concept. Because of the training the principal has received, he/she is providing the necessary leadership to promote elementary school science. An important outcome of the project has been the "ripple effect." The teams are effecting the same programmatic changes in schools throughout the first Tennessee Education Service Center. Also, a major asset of the project's activities have been to establish collaborative relationships with educational institutions and other groups interested in improving elementary school science. The project is serving as a model for cooperation among the public elementary schools, higher education and the Tennessee State Department of Education for maintaining a viable elementary science program in Northeast Tennessee.

REFERENCES

American Association for the Advancement of Science. (1989). Project 2061: Science for all Americans. Washington, D. C.

Carlson, R. O. (1965). Barriers to change in public schools. In Change Processes in the Public Schools. Eugene, Oregon: Center for the Advanced Study of Educational Administration. The University of Oregon at Eugene.

Gall, M. D., Haisely, F. G., Baker, R. G., and Perez, M. (1984, April). The current status of staff development activities for teachers: A "loose coupling" interpretation. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Hall, G. E., George, A. A. and Rutherford, W. L. (1977). Measuring stages of concern about the innovation: A manual for use of the SOC questionnaire. Austin: Research and Development Center for Teacher Education. The University of Texas at Austin.

Haller, Emil. (1968). Strategies for change. Toronto: Ontario Institute for Studies in Education.

Harris, B. and Bessent, W. (1969). In-service education: A Guide to Better Practice. Englewood Cliffs, N.J.: Prentice Hall.

Leggett, Diana and Hoyle, Sharon. (1987). Preparing teachers for collaboration. Educational Leadership, 45 (3), 59-63.

Sergiovanni, T. J., and Elliot, D. L. (1975). Educational and Organizational Leadership in Elementary Schools. Englewood Cliffs, N.J.: Prentice Hall.

Figure 1

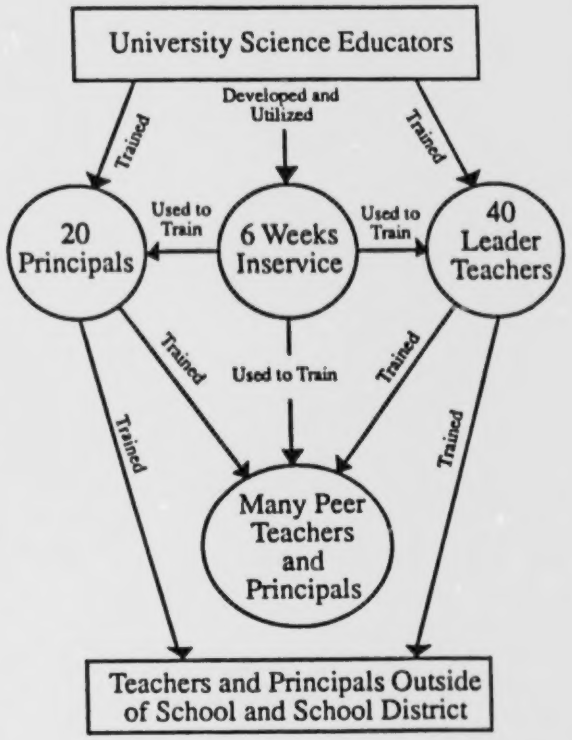
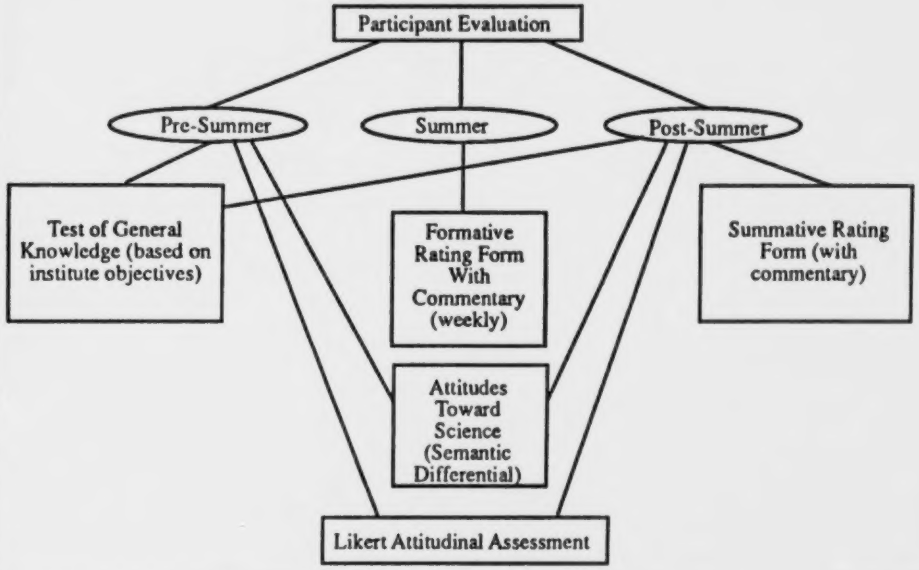

University Science Educators
Developed and Utilized
Trained
Trained
20 Principals
Used to Train
6 Weeks Inservice
Used to Train
40 Leader Teachers
Trained
Used to Train
Trained
Trained
Trained
Many Peer Teachers and Principals
Teachers and Principals Outside of School and School District

Figure II


Participant Evaluation
Pre-Summer
Summer
Post-Summer
Test of General Knowledge (based on institute objectives)
Formative Rating Form With Commentary (weekly)
Summative Rating Form (with commentary)
Attitudes Toward Science (Semantic Differential)
Likert Attitudinal Assessment

L.A.S.E.R.S AND LANGUAGE ARTS: NATURAL LINKS

Aline M. Stomfay-Stitz, Ed.D.
Nicholls State University, P.O. Box 2035,
Thibodaux, Louisiana 70310 (504) 448-4319

Thirty-three years ago, scientists discovered lasers, the intensely brilliant light that has opened up new horizons in art, music, medicine, education, weaponry, industry, and telecommunications. Students in our middle school classrooms may be a part of this technological revolution by developing an awareness of the process and applications of lasers. At the same time, language arts skills can be strengthened by activities that include productive (speaking and writing) and receptive(reading and listening) language. Many of these skills will be essential for later work in the secondary science area. Lasers and language arts can develop a natural affinity in the middle school classroom.

L.A.S.E.R. is an acronym, of course, that stands for Light Amplification by Stimulated Emission of Radiation, invented in 1960 by Theodore H. Maiman and based on the studies of Charles H. Townes and Arthur L. Schawlow in 1958. The intense beam of light resulted when a second source of light flashed through a synthetic rod containing a ruby crystal.

Since 1960, laser technology has grown to include a myriad of processes and applications. Lasers can force energy across fiber optic cables thinner than human hair. The medical profession has adopted laser technology to diagnose and heal many ailments and disabilities.
The compact laser disc has replaced the black cylinder as a standard recording device. The interactive laser videodisc is another innovation to enter our classrooms. Lasers can cut, weld, drill, or imprint designs. With miniaturization, new applications for industrial and commercial use have been quickly turned into new consumer products. Lasers have taken a valid place in the technology of the new decade with exciting possibilities ahead.

Emphasis on test and drill in a back-to-basics mode has resulted in lessened interest or even time for science. Yet an activity-oriented, inquiry-based approach can improve the attitudes of children toward science and school as well. One of the primary needs of society is for "scientifically literate citizens to be capable of making humanitarian decisions about a whole host of social, economic and technological problems" (Carin and Sund, 1980: 65).

In addition, activity-oriented science can also increase language and general knowledge (Esler and Esler, 1981). Creativity, communication, and expanded career awareness can be considered equally valid goals for science education (Abruscato, 1982). Finally, our students can refine their skills in communication. Through relevant activities they can sharpen language subskills such as defining, describing, and recording (Gega, 1986). A science curriculum can be linked naturally with language arts, enhanced by a study of lasers as an area of interest to the middle school student.

LASERS AND LANGUAGE ARTS IN A REAL WORLD SETTING

Many of the students in the fifth grade language arts class that I taught in 1988 revealed only limited knowledge about lasers. The popular laser-and-light show combined with music introduced young people to a new form of entertainment. The "laser gun" on their electronic games was the usual first concept they acquired. However, fewer students were aware that a plexiglass-enclosed helium laser scanned the UPC zebra stripes on products as they zipped across the checkout counter. As our discussions and exploration of lasers continued, students brought in newspaper clippings on laser weapons or compact laser disc innovations such as an entire set of encyclopedias on one disk (MECC, 1989). Since the the war in the Gulf, students today are even more aware of the role of lasers in new weaponry being used for the first time. We began to brainstorm, map, discuss, and write about the bright future ahead for laser technology.

Teachers in growing numbers have adopted an integrated approach to the language arts as they prepare students for the nineties. Connections are made with language opportunities in other areas of the curriculum. The expanding whole language approach includes language in situations that are "meaningful, functional, and genuine" along with the usual mechanics (Hoskisson, 1987: 50). Linking lasers with language arts, based on a wide variety of resources, can bring the real world of science and technology to your classroom.

LEARNING ACTIVITIES THAT LINK THE LANGUAGE ARTS WITH AN EXPLORATION OF LASERS

Two major areas define the language arts, productive language, speaking and writing, and receptive language, reading and listening. Teachers will recognize other possibilities that arise from the interests of their own students. Here are some sample activities:

PRODUCTIVE LANGUAGE; SPEAKING

Vocabulary for Oral Language

. Using correct terminology: Compile a Class Laser Vocabulary Book with terms and definitions (i.e. photon, hologram, fiber optics, ruby crystal). Copy into individual

Learning Logs with additional terms from glossaries in trade books. Definitions can be added to a software program such as Vocabulary Challenge(Mindscape).

. Find other acryonyms used in the present (i.e., EPA, UNICEF) or in the past (i.e., New Deal era - NRA, WPA).

Interviews

. All language modes are involved: listening, talking, reading, and writing. Resource persons to contact: surgeons, such as an eye or dental surgeon, or an opthalmologist using lasers, a laser technician(from a laser-and-light show), physics professor from a nearby college, store manager to explain laser bar code scanner, or electronics engineer/instructor to explain and demonstrate compact laser disc player or interactive videodisc. Tape record interviews for class playback. A videotaped interview would also be worthwhile if a camcorder is available. Students may wish to use a Story Board to plan a videotape titled, "Careers in Lasers."

. "Interview" (by way of computer modem) students at Saw Mill Road School, Bellmore, New York who have an art program for producing holograms, a photography process that uses lasers (Bloom, 1989).

Discussions

. Simulated television show on lasers including graphics. Rehearse and videotape, if possible.

. Panel discussion on social problems and student-generated questions, such as: "Should laser beam weapons that blind be developed by the military?" or "Should lasers be owned only by hospitals, corporations or other organizations?" Future problems of society can be meshed with the new technology to generate critical thinking needed for good citizenship.

Oral Report Presentations(based on written reports)

. Brainstorming should shape direction for various topics which could be : Uses of laser technology in medicine, art, music, recording, industry, telecommunications and military; scientists and discoveries (Abbot, 1984); similarities and differences between lasers and other sources of light; lasers in measurement; holography as an art medium; safety for laser use; and careers in laser technology. Organization of information, rehearsal, and presentation with student-produced visuals(including videotapes, recordings) should be stressed.

PRODUCTIVE LANGUAGE: WRITING

Letter Writing:

. For information: Organizations such as the Laser Institute or for product catalogs.(See Resource Directory).
. For career awareness: Society for Women Engineers or Chronicle Guidance publications.(See Resource Directory).
. To persuade: Follow-up to group discussions on questions of importance to society. Write letters to their representatives in Congress expressing views on emerging laser technology.
. Simulated letter: From one inventor to a fellow scientist describing first laser experiment. Can read original article from a New York Times announcement in 1960 (Sullivan, 1978).
. To communicate: One of the inventors, Charles H. Townes, Nobel Prize winner is at the University of California, Berkeley. Can share their own ideas about laser discoveries after reading about his work (Townes, 1984).

Journal Writing:

. Learning Logs: Record expanding knowledge of lasers, notetaking from trade books; record questions raised on problems for society; diagrams and other graphics that explain lasers; and their own personal reactions to what they have read.

Writing Research Reports:

Five steps are included: Step 1: Brainstorming for topics and choices including a whole class session with semantic webbing or clustering. Review of library skills, such as use of the Reader's Guide to Periodicals, notetaking); Step 2: Outlining, first draft, and editing, planning of visual aids. Use of computer software programs, such as Children's Writing and Publishing Center (Intellectual Software), Prewrite or Mastertype's Writer(Mindscape) to enhance editing and revision skills; Step 3: Written and individual/group oral reports. Word processing programs may also generate diagrams and graphics. Teacher can chart on poster-size paper any questions that arise about the future problems lasers could cause in society; Step 4: Evaluation: Group discussion of questions and issues, such as safety or possession of lasers; and Step 5: Presentation or exhibit of written reports and visuals in school media center or on the school central hall bulletin board. Article in local newspaper or district school system newsletter. Compilation of reports in a Parent Newsletter. Parent viewing of videotapes, if made.

RECEPTIVE LANGUAGE; READING

. Plan well in advance because your background reading and the assembly of your resources will be time-consuming. These first steps will naturally require a broad spectrum of trade books, information books, and articles from educational and scientific journals.(Learn along with your students.)

. Alert your media center to your requirements because books may need to be procured through an interlibrary loan . Students need to have access to informational materials, reading and absorbing the meanings and implications from what they have read.

. Small group discussions or teacher/student conferences could serve as a starting point for helping them glean what may be inferences or suppositions from the printed pages.

Historical Research:

. Science fiction and comic strip genre from past decades(i.e. H.G. Wells, Buck Rogers, Flash Gordon) to find characters who used "heat rays," forerunner of laser light (Barrier, 1981).

LASERS AND LANGUAGE ARTS: A FULL CIRCLE

Lasers appear to be taking a quantum leap forward into the new century with humanity still unsure of the ethical consequences of some applications. Our future citizens, perhaps a laser technician or engineer now in our classes, will need to live with many of the decisions being made today. The problems of society and laser technology are linked naturally with the language arts. Our students can develop an awareness for the new marvel of science. At the same time, they can also practice the communication skills needed to assess new ideas and propose solutions as they listen, speak, read, and write about lasers.

References:

Abbot, D., ed.(1984). *Biographical dictionary of scientists.* New York: Peter Bedrick Books.

Abruscato, J. (1982). *Teaching children science.* Englewood Cliffs, NJ: Prentice-Hall.

Bloom, C.(4 April 1989). "Laser 3-D lessons." *New York Times Education:* 42.

Carin, A.A. and Sund, R.B.(1980). *Teaching science through discovery.* Columbus, OH: Merrill Publishing.

Esler, W.K. and Esler, M.K.(1984). *Teaching elementary science.* Belmont, CA: Wadsworth Publishing.

Gega, P. (1986). *Science in elementary education.* New York: John Wiley & Sons.

Hoskisson, K. and Tompkins, G.E. (1987). Language arts: Content and teaching strategies. Columbus: Merrill Publishing.

MECC (1989). *Catalog.* St. Paul, MN: Minnesota Educational Computer Consortium.

Panacosta, P. (1987). *Splendid voyage: An introduction to the new sciences and new technologies.* Englewood-Cliffs, NJ: Prentice-Hall.

Sullivan, W., ed. (1978). *Science in the twentieth century.* New York: Arno Press. Reprint of article on original discovery by Theodore Maiman in the *New York Times.* 8 July 1960.

Townes, C.H. (November 1984). "Harnessing light." *Science 84*: 153-155.

RESOURCE DIRECTORY; LASER LEARNING ACTIVITIES

MIDDLE GRADES

Reference Books:

Abbot, D., ed. (1984). Biographical dictionary of scientists. Bedrick Books.

Barrier, M., ed.(1981). Smithsonian book of comic-book comics. Harry N. Abrams.

Mount, E., ed. (1987). Milestones in science and technology. Oryx Press.

Sullivan, W., ed. (1978). Science in the twentieth century. Arno Press.

Books and Magazine Articles:

Boraiko, A. and O´Rear, C. (March 1984). The laser: ´A splendid light.´ National Geographic. 165: 335-363.

Bova, B. (1971). Amazing Laser. Westminster Press.

Caulfield, H.J. (March 1984). The wonder of holography. National Geographic. 165: 365-377. Hologram on cover.

Filson, B.(1984). Exploring with lasers. Julian Messner.

McKie, R. (1983). Electronic revolution: Lasers. Franklin Watts.

Mims, F. (1977). Lasers: Incredible machines. David McKay.

Stevens, L. (1985). Laser basics: An introduction for young people. Prentice-Hall.

Superlights! National Geographic World. October, 1987.

TEACHERS

Asimov, I. (1984). Asimov´s New Guide to Science. Basic Books.

Balisteri, J.P.(September/October 1985). Introducing students to laser technology for under $350. Technology Teacher. 45: 23-24.

Bloom, C. (4 April 1989). Laser 3-D lessons. New York Times Education 42.

Bray, Jane S. (March 1986). I finally got a laser--Now what? Science Teacher.

Hecht, J.(1987). *Laser guidebook*. McGraw-Hill.

Lally, S. (October 1988). Healing with lasers. *Prevention.* 30-31, 102-110.

Maurer, A (1982). *Lasers: Light wave of the future*. Arco.

------. (April-May 1988). Torch of a thousand suns, *Modern Maturity.* 56-61.

Pagacosta, P.(1987). *Splendid voyage: An introduction to the new sciences and new technologies*. Prentice-Hall. Chapter on Lasers.

Patel, C. K. (September 1987). Strategic defense and directed-energy weapons. *Scientific American.* 257:39-45.

Tomaszkiewicz, F. (September 1988). Holography in the junior high. *Art Education* 41: 20-24.

Townes, C. H.(November 1984). Harnessing light. *Science 84*.

OTHER RESOURCES

Careers in Lasers

Laser Institute of America, 5151 Monroe St., Toledo, OH 43623. "Careers and Educational Programs in Lasers and Electro-Optics"(free).

Society of Women Engineers, United Engineering Center, Room 304, 345 East 49th St., New York, NY 10017. "Women in Engineering"(free).

"Laser Electro-optic Technicians." Brief 415($3.0[illegible] Chronicle Guidance Publications, Aurora Street Exte[illegible]ion, P.O. Box 1190, Moravia, NY 13118-1190.

MUSEUMS

Charles H. Townes Center, South Carolina State Museum, 301 Gervais St., P.O. Box 100107, Columbia, SC 29203-3107. Videotape on the life of Townes and extensive exhibits on laser technology.

Museum of Holography, 11 Mercer St., New York, NY 10013. Catalog of books and materials.

OTHER MATERIALS

Delta Education, P.O. Box M, Nashua, NH 03061-6012. "Lenses and Mirrors" Kit and Teacher's Guide (Grades 5-6).
Edmund Scientific Catalog, section on Lasers, 101 E. Gloucester Pike, Barrington, NJ 08007-1380

Knowledge Unlimited, Inc., P.O. Box 52, Madison, WI 53701-0052. "Fusion: The Ultimate Energy Answer," filmstrip in the "Science Discovery Series" including laser beams.

Hawkhill Associates, Inc., 125 E. Gilman St., Madison, WI 53703. "Laser Physicist", 10 mins., sound filmstrip or video cassette for purchase or rental, in the "People in Science Today" series.

"Lasers." Video cassette, 38 mins. Grs. 7-10. Clearvue, Inc., 6465 N. Avondale Ave., Chicago, IL 60631-1996.

"Light." Physical Science Unit, Vol. III. Interactive laser videodisc. Grs. 4-8. Windows on Science, Optical Data Corporation, 30 Technology Dr., Box 4919, Warren, NJ 07060.

MECC etc. (Emerging Technology for Classrooms). Catalog., 3490 Lexington Ave., North, St. Paul, MN 55126.

DIGGING DEEPER - BACKGROUND READING FROM SCIENCE BOOKS AND JOURNALS

I. HOLOGRAPHY

Altman, C. (April 1988). Pre-Newtonian holograms or how to make holograms without the bother of inertia and vibrations. Physics Teacher 26: 223-224.

Collier, R.J. et al. (1971). Optical holography. Academic Press.

Latham, E.R. (October 1986). Holography in the science classroom. Physics Teacher 24: 395-400.

Leith, E. (October 1976). White light holography. Scientific American 235: 80-95.

Linthwaite, M. and Shimmens, C. (September 1987). Simple method of producing good-quality holograms without the need for expensive equipment. Physics Teacher 25:382-383.

Saxby, G. (1980). Holograms. London: Focal Press.

Schlegel, R.D. (May/June 1986). Laser holography: High tech with high potential for learning activities. Technology Teacher 45: 23-26.

Spetzlee, H.A. (February 1986). Interesting examples of holography interferometry. Physics Teacher 24: 80-85.

Unterseher, F. and Hansen, J. et al. (1987). Holography handbook: Making holograms the easy way. Berkeley, CA: Ross Books (P.O. Box 4340, Berkeley, CA 94704).

II. LASERS

Benrey, R. (1974). How to build a low cost laser. Rochelle Park, NJ: Hayden Book Co.

Brown, S. (1974). Popular optics. Available through the Edmund catalog (101 E. Gloucester Pike, Barrington, NJ 08007). Written" for non-technical" person " without a math background."

Browning, T. (August 1986). Laser equipment enhanced my program. Vocational Education Journal 61: 41-42.

Burns, W.E. (April 1986). A career in laser technology. Industrial Education 75: 9-10.

Findsen, E.W. and Ondrias, M.R. (June 1986). Lasers: A valuable tool for chemists. *Journal of Chemical Education* 65: 621-622.

Fridling, B.E. (July/August 1988). Lasers highlight policy blindspots. *Bulletin of the Atomic Scientists* 44: 36+.

Kovalenko, L.J. and Leone, S.R. (August 1988). Innovative laser techniques in chemical kinetics: A pedagogical survey. *Journal of Chemical Education* 65: 621-622.

Lytle, J. (November 1986). Laser technology is primed for the classroom. *Industrial Education* 75: 22.

Nardo, D. (1990). *Lasers: Humanity's Magic Light.* San Diego, CA: Lucent Books, Inc. P.O. Box 289011, San Diego, CA 92128-9011. Encyclopedia of Discovery and Invention series.

Nussenzveig, H.M. (April 1977). The theory of the rainbow. *Scientific American* 236: 116-127.

Ryan, J.A. and Handzos, J.J. Jr. (January 1988). Earth model with laser beam simulating seismic ray paths. *Journal of Geology Education* 36: 11-14.

Schneider, H. (1978). *Laser light.* New York: Mc-Graw-Hill.

Walker, J. (August 1980). Dazzling laser displays that shed light on light. *Scientific American* 243: 158-167.

Willey, C.G. (December 1986). Laser tracing bracket. *Physics Teacher* 24: 558.

THE HEALTH ACADEMY: A MODEL PROJECT ENCOURAGING MINORITY STUDENTS TO ENTER HEALTH CAREERS

Natalie Hannon, Ph.D.
Director of Training
Bronx-Lebanon Hospital Center
1775 Grand Concourse
Bronx, New York 10457

Ronald Paul, M.A.
Health Academy Coordinator
William H. Taft High School
240 East 172nd Street
Bronx, New York 10457

Lisa Brandon-Rodriguez
Education Coordinator
Bronx-Lebanon Hospital Center
1775 Grand Concourse
Bronx, New York 10457

The Health Academy is a joint effort between Bronx-Lebanon Hospital Center and William Howard Taft High School. The Hospital and the School are three blocks apart in the middle of the South Bronx in the poorest Congressional district in the United States. It is estimated that 60% of South Bronx adults do not have high school diplomas; and 47% are on public assistance.

The Hospital serves as an economic anchor for the South Bronx. It is the largest private employer in the South Bronx. It also provides the community with drug addiction treatment, social welfare services, housing job training, counseling, and health education. However, Bronx-Lebanon is, like other hospitals, facing a shortage of skilled health care workers. Given this shortage, and the Hospital's commitment to the community, Bronx-Lebanon approached Taft High School to develop a Health Academy which would provide students with the opportunity to explore, in theory and in practice, the vast array of professions and career paths available in the health field.

The 1988-89 student population at Taft was 2420: 48% Hispanic, 44% Black, 5% Asian and 3% white. Of Taft's 1988 class of 698 students, 22% graduated within the four years, 24% were still enrolled, 21% were discharged, and 33% dropped out. Taft, under new Board of Education leadership and a new principal, was happy to collaborate in a program which would help their students succeed academically and vocationally.

Support for the program was received from the United Hospital Fund, the New York State Department of Health, and the New York City Board of Education.

The Academy of Health Program

The Academy began in September, 1990 with fifty-six high school freshmen. Although the Academy is encouraging all students to seek post-secondary education, it exposes the students to three separate options: one for those planning to go to a four year college, one for those planning to attend a two year college, and one for those who wish to enter the work force. It is the goal of the Academy to start students on their way to career ranging from nurse's aide to physician.

While there are other high school - health career programs, this is one of the only programs without entry requirements based on grade point average or standardized test scores. Students were accepted into the program solely based on two criteria: attendance and interest in a health career.

The Health Academy students have programs that are both different and longer than most of the other freshmen. During the regular school day, in addition to the required subjects, there are two additional periods of science and math. There is also a class taught by members of the staff of Bronx-Lebanon. The students are learning what the vital signs are and how they can be determined. The pulse was the first vital sign covered. At the end of the unit about the pulse, the students were given a written and practical exam. If the student passed both parts of the test, the student received a Certificate of Achievement. The students then go on to learn about temperature, respiration and blood pressure. They are learning to chart the vital signs, and to learn to use thermometers, stethoscopes, and sphygmomanometers.

There are extra periods for the students on Tuesdays and Thursdays where the students are required to take a Health Exploratory class and a Science Exploratory class. The Health Exploratory is an introduction to being a health care worker. The students learn about the ethical and legal roles and responsibilities of health care workers. The Science Exploratory helps the students develop the science skills necessary for success in the health field.

A unique feature of the program is Wednesday afternoon. Students are taken to Bronx-Lebanon Hospital to participate in activities for approximately two hours per week. During the first semester, the students learned about the various areas and careers in a hospital. Students toured the Emergency Room and saw doctors treating patients. They learned what it takes to be a pharmacist or a security officer. They filled out job applications and then learned what a prospective employer looks for in an application. They have gone to the neo-natal unit of the hospital, "scrubbed" and put on gowns so that they could go to the other side of the glass where the babies are.

In the second semester the student was assigned a mentor.

Staff from the Hospital, including psychiatrists, radiologists, engineers, computer specialists, and nurse volunteered their time to serve as role models for the students to give them in-depth knowledge of a specific health career. In the students' next three years, they will be increasingly involved with the different areas of the Hospital doing projects, assignments, and hands-on work. They will be doing mini-internships, and rotations through the different areas. Each year we will begin working with another group of in-coming freshmen.

Future Plans

It is still too early to evaluate the program. Currently, the strength of the program is its weakness: the fact that we did not "cream" the students. We are finding that the children though extremely motivated need a great deal of extra help in reading and math. Since the program did not choose the students based on their academic ability we find that we have children in the program who range the gamut from children who read above grade level to those who read on an elementary school level. We are trying to rectify this situation be linking up with one of the Bronx colleges, Lehman College. The students will receive either enhancement or enrichment, depending upon the need of the student, in reading, writing, math and science.

The program does seem to be a success in terms of keeping the students' motivation high. In the fall semster, the Academy students achieved the highest attendance record of all the special ninth grade academic units at Taft. The students are excited about the program. One student tells about a special corner in her bedroom which is devoted to everything she has received from the Health Academy. Another student has passed all of her subjects in high school, after she hardly passed anything in junior high because she wants to become part of the Hospital when she graduates. With the input of the local college, the Bronx-Lebanon/Taft High School Academy of Health should become the win-win program it is designed to be. At-risk students will succeed for Taft; and Bronx-Lebanon Hospital Center will gain a group of health care professionals in the future.

TOWARD THE TWENTY-FIRST CENTURY: PROBLEM SOLVING THROUGH SCIENCE, TECHNOLOGY AND SOCIETY FOR A MIDDLE-LEVEL SCIENCE CURRICULUM

- -

William T. Peruzzi, Project Coordinator
New York Science, Technology and Society Education Project
89 Washington Avenue, RM 232-M
Albany, NY 12234

The New York Science, Technology and Society Education Project (NYSTEP) is a joint effort of the Atmospheric Sciences Research Center at the State University of New York at Albany (SUNY-A), the Bureau of Science Education of the New York State Education Department (NYSED), and the New York Power Pool.[1] These three organizations have a unique programmatic and organizational relationship known as the New York Science, Technology and Society Project (NYSTEP) and have worked together in contractual partnership since 1982. This partnership has developed award-winning elementary and secondary school energy education curricula, and provided staff development training in their use to New York State teachers as a component of dissemination.

The NYSTEP, whose most recent recognition award is from the National Association for Industry-Education Cooperation (September, 1988), now has proposed to enhance the scientific literacy of middle-level (grades 7-9) students and to assure appropriate participation of underrepresented minorities and females in science and science education.

Over a four-year period, twelve Science, Technology and Society (STS) modules are being developed and field-tested by NYSTEP using National Science Foundation funds. The NYSED is using State funds to revise concurrently the middle-level science syllabus and the Regents Competency Test in Science so that both match the proposed modules. The modules will then be disseminated statewide by NYSTEP's forty Resource Agents who will perform staff development activities for middle-level science teachers using funds provided by the New York Power Pool and the New York State Education Department.

ACTIVITIES

The curricular materials under development are twelve middle-level science modules that emphasize problem solving and decision-making through Science, Technology and Society (STS) issues. In order to maximize the use of these modules, the New York State Education Department (NYSED) is funding, for concurrent and parallel development, major revisions of the middle-level New York State science syllabus and the New York State Regents Competency Test in science for grades 7-9. In effect, changes in all three components -- the programmatic curriculum modules, the syllabus (with its intended learning outcomes), and the testing program -- complement each other and increase the likelihood of appropriate use of each by the approximately 5,000 middle-level science teachers and 600,000 middle-level students in New York State.

The other set of ongoing activities relates to providing staff development for the middle-level science teachers to whom the modules will be disseminated. This set of activities is funded by cost-sharing through sources other than the National Science Foundation (NSF). Interwoven staff development networks already in place bring appropriate awareness and training to science teachers and supervisors. This training is expected to result in major instructional style changes for science education as it takes place in middle-level science classrooms of the future.

PRE-AWARD ACTIVITIES

Three organizations joined together in 1982 to develop and disseminate energy education materials in New York State -- the Atmospheric Sciences Research Center at the State University of New York at Albany (SUNY-A); the Bureau of Science Education of the State Education Department of New York State (NYSED); and the New York Power Pool (NYPP), a private sector association of investor-owned utilities and the New York Power Authority. These partners sought and obtained funding from the NSF to share costs as project emphasis was broadened from energy education to Science, Technology and Society (STS) education. Accordingly, the name of this organizational relationship was changed to the New York Science, Technology and Society Project (NYSTEP).

During the pre-award period the following middle-level science education activities were conducted by NYSTEP in conjunction with outside consultants and NYSED Bureau of Science Education staff members:

1. Completion of a statewide needs assessment involving middle-level science teachers and administrators.

2. Completion of a review of the literature on the nature of middle-level students, science education, and Science, Technology and Society (STS) education.

3. Formation of and initial meetings of an advisory committee composed of private and public sector scientists, and pre-college and college educators.

4. Completion of an outline of a new middle-level science syllabus (framework) for New York State.

5. Production of a prototype STS module in solid waste management to serve as the model for development of twelve additional middle-level science modules.

During the summer of 1988 NYSTEP began to prepare for change. Project plans were presented and refined at a summer institute held to reorient the educators comprising the NYSTEP statewide network for staff development, which includes forty resource agents and ten private sector utility educational representatives.

Also, during the summer of 1988, two middle-level science teacher/consultants worked twenty days each with NYSTEP and NYSED staff drafting a needs assessment instrument, conducting a literature review, and developing working documents and recommendations for the project's advisory committee to be convened in Albany, New York during the winter of 1988-1989. The project advisory committee members are:

- Estella Abel, Supervisor and Teacher, Mount Vernon High School
- Kathaleen Burke, Teacher, Buffalo Magnet School
- John Cafarella, Supervisor, SCD 10, NYC
- Michelle Cambier, Bilingual Supervisor, NYC Board of Education
- Audrey Champagne, Scientist, AAAS (Now at SUNY Albany)
- Willard Jacobson, Research Coordinator, Second International Science Study, Teachers College, Columbia University
- Kenneth Male, Scientist, Capital Region Technology Development Council
- Michael Pisterzi, Engineer, IBM
- Conrad Toepfer, Educator, SUNY Buffalo
- Nancy Van Vranken, Teacher, St. Bernard's School
- Theodore Bredderman, Educator, SUNY Albany (Evaluator)

The NYSTEP Staff are:

- Carolyn Graham, Project Director
- William Peruzzi, Coordinator
- Dennis Cheek, Coordinator of Curriculum Development
- Lesa Clark, Administrative Assistant
- Kate McGinty, Secretary

NSF AWARD ACTIVITIES

A. Development of middle-level science modules.

The curricular modules under development through NYSTEP are intended for all middle-level students. The process of development assures that the modules are particularly appropriate for use by females and minority students, traditionally underrepresented in scientifically and technically based jobs.

In the 1986/87 school year, black, Hispanic, and other minority students accounted for 37.5% of the student population in New York State. For the "Big Five" urban centers -- Buffalo, New York City, Rochester, Syracuse, and Yonkers -- minority students accounted for 74.6% of the school population. The NYSED has developed a comprehensive, long-term policy and implementation strategy for educating at-risk children and youth and for ensuring that schools have the necessary resources and assistance to meet the challenges of economically disadvantaged students. The NYSTEP staff seeks to support those efforts. The initial materials development activities of this proposal have taken place in the urban settings of the "Big Five" cities. Readily available minority student target audiences, programs intended to provide support for at-risk students, and personnel experienced in urban setting teaching have actively supported the development and refinement of appropriate curricular materials.

The NYSTEP STS modules developed thus far are:

- Communication (Draft Edition)
- Epidemics (Draft Edition)
- Land Use (Field Test Edition)
- Natural Disasters (Field Test Edition)
- Solid Waste Management (Draft Edition)
- The Future (Draft Edition)
- Transportation (Field Test Edition)
- Water Resources (Field Test Edition)
- Wildlife (Draft Edition)

Modules to be developed during the summer of 1991 are Energy in the Environment; Energy in a Technological World; and Climatic Change.

The NYSTEP Resource Agents are from various geographical locations statewide. They help conduct further field-testing of the curricular products in contrasting settings (urban, suburban, rural), so that the proposed modules will be applicable statewide.

National Science Foundation (NSF) funds have been used to hire a NYSTEP coordinator of curriculum development who supervises the four curriculum production teams, one each from the "Big Five" cities (only 4 cities participate in a given year). Each team consists of two teacher writers, two private sector scientist writers/consultants, underrepresented minority students who serve as curriculum development advisors, and underrepresented minority teacher(s) in training who supervise the student advisors and also serve as local curriculum development advisors.

The eight teacher writers were trained in STS and in curriculum writing by NYSTEP and NYSED staff and scientists and consultants at a summer institute. Private sector scientists were recruited from each of the "Big Five" cities, and they became active members of their curriculum production teams as writer participants as well as consultants. The advisory role for the underrepresented minority students and the one or more teachers-in-training on each curriculum development team included participating in pre-writing activities such as literature searches, reading drafts for face validity, pilot-testing the "hands-on" and "minds-on" activities produced, and making suggestions for improvement based upon their experiences and viewpoints.

The science directors for the "Big Five" cities hosted the curriculum production teams and served as non-paid liaison persons to the NYSTEP project. Each director worked with the NYSTEP staff to identify and recruit the middle-level teachers who served as paid curriculum writers. Each director located physical sites within his or her school district where curriculum development teams met and curriculum development took place.

The science directors (and NYSTEP staff) have seen that:

1. For each year, their writing team has two science teachers from grade 7, 8 or 9, at least one of whom is a female and/or underrepresented minority group member.

2. Their writing team has at least two paid secondary school student advisors and at least one teacher-in-training advisor(s) all of whom are members of underrepresented minority groups, and of whom at least 50% shall be females. (Advisors are paid through New York State's legislatively-funded Science and Technology Entry Program (STEP) using Structured Education Support Program (SESP) funds and Teacher Opportunity Corp (TOC) funds, all of which are administered by NYSED).

Each curriculum development team uses an "adopt and adapt" procedure to produce instructional activities. Each team, during the summer assembles activities into a middle-level science module, in draft form ready for pilot testing within their districts. Following further revision each module is field tested at New York State middle-level schools and revised to final form. That production level is intended to produce a total of twelve modules -- four for grade 7, four for grade 8, and four for grade 9. The NYSTEP staff has made periodic on-site visits to help the curriculum development teams as work proceeds and coordinates rewrites.

B. Staff development activities.

Before educational materials are used in the classroom, they must gain the attention of teachers, supervisors and administrators. Moreover, faced with competing demands and limited time, all must be convinced that the materials are significant, of high quality, and easy to use. In order to effectively introduce the proposed middle-level science modules, the project makes use of its own and other professional staff development networks in the state, all of which follow the "teachers learning from teachers model". Each of these networks has been a highly effective way of involving teachers in staff development activities:

(1) The NYSTEP network is composed of forty resource agents (typically classroom teachers) and ten private sector NYPP Educational Representatives who together developed and conducted teacher workshop activities while disseminating energy education booklets. This network has continued to be maintained through private sector NYPP funding as the proposed middle-level modules are being developed. Staff development activities by resource agents include conducting workshops, inservice courses, and summer institutes; providing technical assistance to local school staff; and encouraging other educational activities such as local curriculum development.

(2) The Teacher Resource and Computer Training Centers, 101 statewide, are legislatively funded and administered through NYSED. Each is operated by independent boards, on which most members are precollege teachers. Included in the Teacher Center mandate is a provision to,

...retrain teachers and other education personnel to become better qualified to teach in subject areas necessary to prepare students for the high technology era – mathematics, science and computer technology.

In the teacher center model all participating groups, school districts, private sector businesses and industries, and post-secondary institutions, work collaboratively to provide staff development services to teachers. The NYSTEP Resource Agents have been oriented to use of teacher centers for conducting workshops and some agents conduct workshops through them now.

(3) The Staff/Curriculum Development Network (S/CDN) is operated cooperatively through NYSED and the state's forty-two intermediate educational agencies (Board of Cooperative Education Services). This network uses teachers as turnkey trainers for state syllabus awareness and dissemination activities. Most recently, the S/CDN has been effectively used by the NYSED Bureau of Science Education to provide extensive, statewide staff development activities associated with the State's new elementary science program evaluation. The S/CDN network has also been a most effective method for statewide teacher staff development for those NYSED Bureau of Science Education secondary school syllabi which have been recently developed, or revised and reissued.

The need to magnify the staff development activities performed by NYSTEP Resource Agents through additional staff development networks is apparent considering the magnitude of the effort; over 1,500 middle-level science teachers in grade 7 in New York State, teach science to 200,000 middle-level students (similar statistics for grades 8 and 9). The mechanisms which have been described will permit vigorous response to an anticipated strong interest in and demand for staff development in STS education, in the new middle-level science modules, and in the new middle-level science syllabus.

The NYSTEP staff also have major responsibility for seeing that private and public sector scientists are integrated into the local and State staff development activities conducted by NYSTEP Resource Agents. This is achieved by staff members serving liaison functions to identified representatives of research organizations such as the Atmospheric Sciences Research Center at SUNY-A, to professional organizations such as the National Association of Education/Industry cooperation and to educational representatives of the electric and gas utilities who help recruit scientists and engineers from that industry.

The development of a comprehensive middle-level science curriculum shall have national applications. The products of curriculum development and the dissemination model will be shared enthusiastically nationwide with other State Education Agencies, school science supervisors, and professional associations in order to encourage and promote widespread dissemination of products and processes, and to aid the efforts of all to restructure middle-level education.

---

[1] Since 1987 additional funding has been provided from Columbia Gas of New York and National Fuel Gas Distribution Corporation.

RESEARCH INTERNSHIPS: AN IDEAL TOOL TO ATTRACT YOUNGSTERS TO CHOOSE CAREERS IN SCIENCE AND TECHNOLOGY

Dana Levine, Liberty Science Center,
Jersey City, NJ 07302

Susan Fahrenholtz, Fordham University at Lincoln Center,
New York, NY 10023

Beatrice A. Klier, New York Academy of Sciences,
New York, NY 10021

Victoria Leyton, Environmental and Occupational Health Sciences Institute,
Piscataway, NJ 08854-5635

The National Science Board recently concluded that, despite slight improvements in student performance in math and science, the United States is far behind other industrialized nations. Not many young people take three or more years of math and science in high school and even fewer decide to major in science or engineering in college. Today, we are experiencing a shortage of trained technical personnel, and by the next century our workforce demands will far outstrip our supply.

To meet the demand we need to change children's attitudes from "science is boring and too hard" to "science is fun", we need to change teachers' and students' low comfort level with science and implant the notion that science and technology literacy are vital prerequisites to participation in a modern democratic society. We need to dispel the idea that science and technology are only for the elite few, and attract more women and minorities to these fields.

There is a growing consensus among scientists and engineers that improving precollege science education in the United States should no longer be left entirely in the hands of precollege educators. In recognizing the need and its responsibility, the scientific and engineering communities has joined in partnership with schools and organizations. Together, these groups have searched for solutions using a variety of approaches.

Successful strategies for expanding the pipeline into science and technology range from introducing more "hands-on" science in the elementary grades to involving middle school students in experiences demonstrating that science and technology pervades everyday life. At the high school level, some science departments offer students a research course, encourage their students to develop projects for science or engineering fairs, and recommend students for research internships outside their four walls.

The "Directory of Student Science Training Programs for High Ability Precollege Students", published each year by Science Service, lists many experiential programs around the country. Most high school student intern programs are administered by universities but other organizations also sponsor research programs. Although these programs display a variety of methods and content areas, most have enjoyed a remarkable success rate in achieving their objective of encouraging students to select careers in science and engineering.

One of the best ways to "initiate" young people into science or engineering is to give them the opportunity to immerse themselves in science and engineering. It is not so much what particular field of research is undertaken, where the program is located, or how it is administered. The essential components are the mentor teaching the student the scientific method in the course of carrying out the research and the one-on-one personal interaction between the student and the mentor. In fact, most scientists and engineers will tell you that, in their adolescent years, a science teacher or a professional scientist or engineer took a sincere interest in them and involved them in scientific or engineering research.

In the New York City - New Jersey metropolitan region, examples of non-profit educational institutions actively sponsoring high school student research are: the New York Academy of Sciences through its Junior Academy; Liberty Science Center - a new science museum; the American Chemical Society via Project SEED; and the Environmental and Occupational Health Sciences Institute - a research organization. These programs, have the primary objective of giving young people the experience of doing research with the aim to attract more bright youngsters into scientific and technological careers. Moreover, they have some common threads:

* they are located in areas where research centers are concentrated;
* they seek students with the interest and ability to participate;
* they locate mentors who are genuinely interested in helping initiate a young person along the path to a science or related career;
* for the most part, they are conducted during the summer when students and mentors have more free time;
* students are encouraged to submit their projects to science and engineering competitions; and
* the programs are free to the students. In fact, students are reimbursed for their travel and other out-of-pocket expenses. The last factor helps to ensure a healthy participation rate among those that could not attend for financial reasons, namely minorities and other disadvantaged youth.

Because these factors can be found in many regions of the United States, replication of experiential science and technology programs is feasible.

The New York Academy of Sciences

The New York Academy of Sciences, a membership organization of professional scientists will celebrate its 175th birthday in 1992. Through the Educational Programs Department, activities designed to enhance science education for the pre-college community of students and teachers have been ongoing for many years.

The Science Research Training Program, established ten years ago, was originally funded by the National Science Foundation and subsequently by the Exxon Corporation; it now receives support from the NSF Young Scholars Program and local school Boards of Education.

Almost 200 students participate each year. Applications are sent to high schools in New York City and nearby counties. High School Juniors' and Seniors' applications are screened, selected students are interviewed by staff, then by the cooperating scientist, and placed in laboratories based upon their interest, school background and proximity to their homes.

The program has two components, Academic Year (part-time after school) and Summer (seven weeks, full time). Many students have participated for more than one year; some have continued while attending college. In addition to the on-site experience, the students attend workshops, seminars and field trips, receive instruction in research paper writing and oral communication, attend a seminar on Ethics, and join the Junior Academy of the New York Academy of Sciences.

In order to guarantee that the texture of the program reflects the demography of the region, inner city schools are visited and the program described to both teachers and students. In this way, many students from underrepresented minorities as well as female students learn about the program and subsequently participate.

All of the mentors are volunteers and receive no remuneration for their participation. During the internship, students and their mentors are visited and at the conclusion of the program students deliver a brief talk describing their work and abstracts of their research papers are printed in a Journal.

The program travels easily. Upon receipt of a State legislative Grant, the program was instituted in the semi-rural region of Utica-Rome-Cooperstown in Central New York State. The diversity of sites is reflective of the diversity of scientific research. For example, students worked at Lederle Labs, IBM, Mt. Sinai Medical Center, Environmental Protection Agency, Columbia University School of Engineering, New York Aquarium, Museum of Natural History Courant Institute, NYU, Rockefeller University, etc. In Central New York State, students were engaged in field study at Lake Otsego, with Lyme disease in Westchester, and river pollution in Raritan Bay; also governmental installations such as the Rome Air Development Center, Kensico Dam Water Quality Stations, etc.

Throughout the 10 years almost 2000 students have participated; 75-80% of the students chose science as their major in college or their choice of career. For the past four years, the female participants have equalled or surpassed the number of males in the program. As a result of personal visits to inner city schools, there has been an appreciable increase in the number of unrepresented minorities as participants. Feedback from mentors, parents, educators and students all point to the value of participation in research programs of this caliber.

American Chemical Society

Project SEED (Summer Educational Experience for the Disadvantaged), a national program started in 1968 by the American Chemical Society (ACS), provides opportunities in research for high school students who are least likely to have family role models and contacts in science, i.e. students from low income families. The students find out what chemistry research or development is about, and whether it might interest them as a career.

The mentors volunteer to direct student research because they know it will make a difference in a young person's life. Some mentors have participated for over ten years even though their students rarely start out with a strong lab science background. At the end of the summer, students present their work at a poster session sponsored by a local ACS section and many have used the work as the basis for projects submitted to science fairs.

The primary difference between SEED and other research internships is that SEED students are all from economically disadvantaged homes and the projects must involve chemistry. Recruitment focuses on those urban cities where there is a high concentration of low income students. Potential SEED students are identified by their high school science teachers or the school's science supervisor and selection is made from those who have had chemistry, good attendance records, and an interest in science. The teachers screen out most of the weak students before they apply, but there is no absolute criteria, except for the chemistry course, and students have been selected with C grades in science and math. However, most SEED students are in honors courses and in the top fifth of their class. The most difficult part of the selection process is determining family income; eligibility for a school lunch program is a convenient method. Although students of all races can qualify and participate, in New Jersey, SEED students are primarily Black, Hispanic, or first generation immigrants.

Since mentors devote so much of their time to the student, the final selection must be theirs. The mentor interviews the candidate before the final assignment is made. In only three out of seventy interviews have students been turned down as a result of the interview and all three were placed elsewhere.

It is critical for disadvantaged youngsters to participate in research because they would otherwise rarely come in contact with scientists. Furthermore, urban school districts in New Jersey have less money to spend than suburban school districts on advanced science and math courses. Students from suburban schools often participate in science fairs while those from urban schools usually do not.

SEED students reap other benefits from their summer, such as: writing a resume and interviewing, traveling away from home, interacting with a scientifically and academically oriented peer group, learning to communicate their results by writing and speaking, receiving career and college guidance, obtaining meaningful recommendations to college, and feeling comfortable in a college or corporate environment.

A student finds out about SEED from a concerned science teacher who advises the student that this program is more rewarding than a summer job behind a fast food counter. These teachers motivate students to take the harder, ultimately more satisfying path. Teachers make the initial contact with the ACS SEED Committee, organize peer groups for support, encourage and advise the student, and use the new role models to inspire the next group of students.

Some students who would benefit from SEED do not participate because: 1) the family's need them to earn money during the summer (SEED students will be paid a stipend of $1200), 2) the family needs their services as baby sitters, or 3) the family is reluctant to have their child travel outside the community (especially Hispanic families of females). It is heartening that for every student who turns down a chance to be in SEED ten more want to join. It takes time and energy to recruit them, but there are many bright, hardworking, low income youngsters with an interest in science. The limiting condition in SEED, however, is the number of willing and available mentors.

Stipends for students are stitched together from a combination of sources, primarily the national ACS through contributions of its members, from the Petroleum Research Corporation, and from individual corporations such as Coca Cola. Matching funds and student stipeds are contributed from the North Jersey section of the ACS, local universities and industries - particularly Hoffmann-LaRoche, Ciba-Geigy, and Unilever Research, USA., collaborating programs such as Partners in Science, minority traineeships of the National Science Foundation, and by Job Training Partnership Act (JTPA) funds.

Liberty Science Center

Liberty Science Center's Partners in Science program, a summer research internship for high school students between their junior and senior year of high school, is funded by the Geraldine R. Dodge Foundation and participating high schools.

Approximately one-third of those who are nominated are selected. Candidates are carefully screened; they are first nominated by their high school principal and then submit a high school transcript, teacher recommendations and an application which has many open-ended questions. Promising students are interviewed and matched to a mentor on the basis of transportation needs and field of interest. Students are then interviewed by the prospective mentor before they are accepted into the program. Qualities looked for in a candidate are: ability, interest, maturity, and self-reliance.

Mentors are recruited from university, corporate, and government research facilities in New Jersey in all fields of science, engineering, and mathematics. Examples are: Princeton Plasma Physics Laboratory for nuclear physics, the Hackensack Meadowlands Development Commission for environmental testing, and AT&T Bell Laboratories for electrical engineering.

Since the students are spread throughout the state during the summer, opportunities for them to get to know one another were built into the program. Participants gather at Rutgers University at the start of the summer for a three-day "skills" workshop and thereafter on alternate Mondays for seminars and a concluding research symposium. At the skills workshop, students have a chance to make friends with one another, to learn to think like a scientist, and to acquire some skills essential for research. They analyze and write up a laboratory experiment, carry out problem solving exercises, identify and control variables in experiments, manipulate data using computer software and learn some common sense safety guidelines. The seminars include: talks by mentors about their research and their careers; a workshop on how to write a research paper; oral presentation techniques; a college choices discussion; and preparing a project for science competitions. At the end of August, the program concludes with each student giving either an oral report or poster presentation of his or her research efforts. Several students have continued to work with their mentor during the academic year and into the following summer.

Students are tracked as they complete high school and enter college to see whether they will major in science or engineering. Well over 90% have indicated a career choice in science or engineering.

Partners in Science

	1988	1989	1990
Student Participants:			
Number of Student Participants	18	34	52
Women	17%	53%	59%
Blacks and Hispanics	6%	18%	13%
Urban Schools' Participants	22%	30%	31%
Research Project Areas			
Natural Sciences	45%	44%	60%
Physical Sciences	33%	21%	21%
Engineering, Computer Science	22%	35%	19%
Students Selecting College Majors in Science or Engineering	94%	94%	info. not yet avail.
Intended College Major			
Natural Sciences, Pre-Med.	44%	21%	info. not yet avail.
Physical Sciences	17%	15%	
Engineering, Computer Science	33%	58%	
Undecided or Non-Science Major	6%	6%	
Mentor Participants:			
Number of Mentors	18	31	32
Participants for Second Time		40%	53%
Research Facilities			
University	72%	77%	64%
Corporate	22%	20%	32%
Government	6%	3%	4%

The program is evaluated at the end of the summer by students and mentors. The following comments are typical of student responses to the questionnaires:

> "I learned a staggering amount about research. Interaction with my mentor was the best part of the whole program."
>
> "Before I started I was somewhat concerned about whether I'd be able to handle the challenge. The project added a broad new dimension to my interest in science and increased my self-confidence. I learned many new techniques and I discovered what it is like to be a scientist, how much fun science can be and how exciting pure research can be."

Comments from mentors are overwhelmingly positive.

"_____ is a great pleasure to have in the lab. I am willing to do a lot for a student who says, 'Isn't it exciting to be the first one to know something?'... I would be happy to have hoards of these kids."

"_____ has an excellent intuitive and quantitative understanding of scientific work. He is an extraordinary young man. I have worked with many students over twenty years and have never had one with the range of scientific and interpersonal skills and potential he displayed."

"_____ is truly an outstanding person. Her willingness to work long hours and to study on her own have convinced me that she has that special spark that separates a superior scientist (artist, farmer, etc.) from a mediocre one."

Environmental and Occupational Health Sciences Institute (EOHSI)

EOSHI is jointly sponsored by the University of Medicine and Dentistry of New Jersey, Robert Wood Johnson Medical School and Rutgers, the State University of New Jersey. The faculty/researchers are experts in a variety of fields encompassing toxicology, exposure measurement and assessment, pharmacology, molecular biology, neurosciences, ecology, environmental sciences, occupational health, environmental policy, urban planning and public education. Their scientific research is funded through grants from federal (National Institutes of Health, National Institute of Environmental Health Sciences, Environmental Protection Agency), state (Department of Environmental Protection) or private corporation and foundation sources.

EOHSI primarily trains graduate and medical school students, but recognizes the importance of exposing younger students to the excitement and importance of science. Therefore, last year EOSHI began its summer high school student program with nine students. Although only one year old, the program has successfully filled an important need. The students were recruited through the Liberty Science Center's Partners in Science program and the American Chemical Society's Project SEED. The nine students, seven female and two male participants, two of whom were economically disadvantaged and one of whom was a minority, came from eight New Jersey high schools, six public and two private.

The students worked in a variety of areas from basic science and molecular biology to environmental and biomedical research. The contact between student and mentor is most important since enthusiasm and excitement for science often comes from personal interaction and from the challenge of working as part of a team on a specific project.

Students worked for eight weeks and then presented papers on their research. One student worked with Dr. Allan Conney, an international expert in nutrition and cancer, who was recently awarded an $8 million grant from the NIH. Another worked with Dr. Joanna Burger, a well recognized researcher in the area of ecology. This student's project involved an evaluation of the effects of oil on fish and crabs in the Arthur Kill, a polluted waterway between New Jersey and New York City.

At the end of the eight weeks, students and mentors were asked to complete a questionnaire. Many of the students indicated the program increased their interest in science and in their pursuit of science as a career. The mentors related that this experience for them, too, has been valuable. One said, "I am very pleased with the high caliber and enthusiasm of the ... students. The program seems very well organized and gives the students a variety of experiences both in and out of the lab." Another commented on his student, "I would very much like to have ____ or another high school student from your program working in our lab next summer since we would like to contribute to the science education of high school students and to help them in decisions related to entering careers in the biomedical sciences." And, the following quote from one of the scientists sums up what student internships can accomplish: "The program is excellent and meets a critical need, namely to introduce young people to the excitement of science. It is also an excellent forum to bring scientists and the general public together through students from local communities."

Nothing seems to travel as fast as good news, and the good news at EOHSI is that in 1991 we expect to have more scientists participating in the program and introducing more young people to the excitement of science.

"References"

1. National Science Board (1990). Chapter: Precollege Science and Mathematics in Education, Science and Engineering Indicators - 1989, (pp. 20-35) Washington, DC: National Science Foundation.

2. Worthy, W. (1989). Partnerships Strive to Improve Precollege Science Education, Chem. and Eng. News, 67, 49-50.

3. Science Service, Inc.(1990). 1991 Directory of Student Science Training Programs for High Ability Precollege Students, Washington, DC: Science Service, Inc.

STS CENTRAL TO THE IOWA SCOPE, SEQUENCE, AND COORDINATION CENTERS

Robert E. Yager
Professor, Science Education
769 Van Allen Hall
Science Education Center
The University of Iowa
Iowa City, Iowa 52242
Phone: 319-335-1189
Fax: 319-335-1188

Science/Technology/Society (STS) is seen by many as the major reform in science education today (AAAS, 1989; NSTA, 1982; Piel, 1981; Roy, 1985). Some have even called it a paradigm shift (Hart & Robottom, 1990). STS has grown in importance with every major textbook publisher scrambling to include STS strands or themes; states are incorporating STS into their frameworks; and schools are developing new STS courses--often for students who are not pursuing advanced work in science-technology. The STS interest and actions have moved swiftly since the idea was used as a major course emphasis in Norris Harms' Project Synthesis (1977). STS was identified as the significant direction for science education for the 80s in the National Science Teachers Association (NSTA) Position Paper:

> The goal of science education during the 1980s is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use their knowledge in their everyday decision-making. The scientifically literate person has a substantial knowledge base of facts, concepts, conceptual networks, and process skills which enable the individual to continue and learn logically. This individual both appreciates the value of science and technology in society and understands their limitations (NSTA, 1982).

The Iowa Chautauqua Program was created in 1983 as one of 17 Chautauqua sites that operated as a part of an NSF experiment coordinated by NSTA. The Iowa Program was conceived as a way of helping Iowa teachers and schools move to STS strategies in K-12 classrooms. The program is a developmental model for in-service designed to provide ongoing support for science teachers K-12. Basically the in-service model consists of these features: 1) a two week experience in the summer with STS teaching and learning that includes planning a five day STS module, 2) a two and one-half day fall short course which includes other teachers from the schools of the summer participants, 3) planning and using a 20 day STS module with a pre - post assessment program, and 4) a follow-up short course some months later for sharing the results of the STS teaching and assessment of student learning (Blunck & Yager, 1990).

Ten points are offered to characterize STS classrooms. Such classrooms are those which:

- utilize student identification of problems with local interest and impact as organizers for the course;
- use local resources (human and material) as original sources of information that can be used in problem resolution;
- involve students in seeking information that can be applied in solving real-life problems;
- extend learning beyond the class period, the classroom, the school;
- focus upon the impact of science on each individual student;
- view science content not as something that merely exists for students to master on tests;
- de-emphasize process skills as the "special" skills that should be mastered because they are used by practicing scientists;
- emphasize career awareness--especially careers related to science and technology;
- provide opportunities for students to perform in citizenship roles as they attempt to resolve issues they have identified;
- demonstrate that science and technology are major factors which will impact the future.

STS is seen by NSTA as the best approach for achieving scientific literacy for all high school graduates. NSTA defines a scientifically literate person as one who:

- uses concepts of science and of technology as well as an informed reflection of ethical values in solving everyday problems and making responsible decisions in everyday life, including work and leisure
- engages in responsible personal and civic actions after weighing the possible consequences of alternative options
- defends decisions and actions using rational arguments based on evidence
- engages in science and technology for the excitement and the explanations they provide
- displays curiosity about and appreciation of the natural and human-made world

- applies skepticism, careful methods, logical reasoning, and creativity in investigating the observable universe
- values scientific research and technological problem solving
- locates, collects, analyzes, and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions, and taking actions
- distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information
- remains open to new evidence and the tentativeness of scientific/technological knowledge
- recognizes that science and technology are human endeavors
- weighs the benefits and burdens of scientific and technological development
- recognizes the strengths and limitations of science and technology for advancing human welfare
- analyzes interactions among science, technology, and society
- connects science and technology to other human endeavors, e.g., history, mathematics, the arts, and the humanities
- considers the political, economic, moral, and ethical aspects of science and technology as they relate to personal and global issues
- offers explanations of natural phenomena which may be tested for their validity.

In 1990 NSF awarded five new grants to support five Scope, Sequence, and Coordination (SS&C) Centers. SS&C is the national reform for secondary school science sponsored by NSTA. The 1990-93 sites for developing and testing materials include Houston (Texas) and California--two centers which were supported during the 1989-90 academic year. New centers were established in Iowa, North Carolina, and Puerto Rico. Each of these five centers were funded at a level between $1 and $2 million in August of 1990; a similar grant was awarded at the same time to NSTA to coordinate the national reform package.

Distinguishing elements of the SS&C reform are that they all: 1) take advantage of spaced learning; 2) provide students with experiences with science phenomena before terminology is introduced; 3) build the concepts of science on repeated experiences in different contexts; 4) assess depth of understanding, not just facts or information; and 5) emphasize the application of science to personal and societal problems.

Expected outcomes of the SS&C reform are: 1) a far more scientifically literate citizenry; 2) increased numbers of students, especially females and minorities, studying science at advanced levels; 3) greater understanding of scientific content; 4) new approaches to textbooks and instructional materials; and 5) more effective forms of assessment of student learning.

In Iowa a total of 1,500 K-12 teachers have tried at least one major (four - six weeks) STS module in their classrooms with at least one section of students. This means there are over 50,000 Iowa students who have had STS school experiences in science as defined above. About a third of the teachers involved have experienced great success with their initial STS modules; teachers with such success are invited to consider leadership training with the goal of preparing entire courses, conducting awareness sessions, and participating as a part of the staff for future Chautauqua sessions. One aspect of leadership training is the planning and carrying out of at least one active research project each year. This research is one designed to produce additional evidence of the advantages of STS and thereby illustrate that STS can result in fundamental reform in science teaching.

The Iowa SS&C effort is centered in four districts in Iowa which have endorsed the general SS&C goals and the unique features described in the Iowa proposal. Basic to all our efforts is the use of the essential elements of SS&C reform as elaborated above. In addition to these general features, SS&C in Iowa focuses upon Science/Technology/Society (STS) strategies as a way of realizing the general goals of SS&C. STS in Iowa utilizes the NSTA definition of STS. It reads:

> NSTA views STS as the teaching and learning of science in the context of human experience. It represents an appropriate science education context for all learners. The emerging research is clear in illustrating that learning science in an STS context results in students with more sophisticated concept mastery and ability to use process skills. All students improve in terms of creativity skills, attitude toward science, use of science concepts and processes in their daily living and in responsible personal decision-making.
>
> There are no concepts and/or processes unique to STS; instead STS provides a setting and a reason for considering basic science and technology concepts and processes. STS means determining and experiencing ways that these basic ideas and skills can be observed in society. STS means focusing on real-world problems which

have science and technology components from the students' perspectives, instead of starting with concepts and processes. This allows students to instigate, analyze, and apply concepts and processes to real situations. A good program will have built-in opportunities for the students to extend beyond the classroom to their local communities. These activities should be appropriate for the age of the students and be learner centered. STS should help lay the basis for empowering students so that as future citizens they realize they have the power to make changes and the responsibility to do so (NSTA, 1990).

In addition to STS as a curriculum organizer the Constructivist Learning Model provides the philosophical base for instruction at the Iowa Center. Basic to this model is the proposition that all persons learn by themselves, i.e. each person must construct his/her own meaning by interpreting objects and events in terms of past experiences and the current social situation. The model dates back to the Neapolitan philosopher Giambattista Vico's treatise in 1710. One of Vico's basic ideas was that epistemic agents can know nothing but the cognitive structures they themselves have put together. "To know" means "to know how to make." He substantiates this notion by arguing that one knows a thing only when one can explain it. Such explanations are for others to understand and to use.

Involving teachers in learning in a constructivist mode is central to workshop sessions in each SS&C site and at Iowa Center meetings. The four districts in Iowa who have embraced the SS&C tenants as well as the STS as a delivery system and the constructivist model as a philosophical base are:

Curtis Jeffryes, Center Coordinator
Creston Community Schools
Burton R. Jones Jr. High School
801 North Elm
Creston, Iowa 50801

Shannon Cde Baca, Center Coordinator
Council Bluffs Community Schools
Thomas Jefferson High School
2501 West Broadway
Council Bluffs, Iowa 51501

Mary Sievert, Center Coordinator
Davenport Community Schools
1001 Harrison Street
Davenport, Iowa 52803

Kennard Schaefer, Center Coordinator
Mason City Community Schools
1700 4th Street SE
Mason City, Iowa 50401

A total of 30 teachers are involved at each site. For Creston and Mason City this means all 6-9 teachers are involved as well as industrial technology and several high school instructors. In

Creston, the smallest district, several neighboring districts are also involved as full partners. Teachers, administrators, school board members, and parents are involved as reforms are sought. In Council Bluffs and Davenport, 30 teachers have been designated as writers, developers, and pilot teachers as changes for the entire districts are contempiated. In Council Bluffs, the focus is upon using science as the key for total curriculum reform. In Davenport, the aim is to achieve a major restructuring of the 6-9 science sequence as the district moves to a middle school concept.

Three or four-day workshops have been held prior to the opening of school in the fall or during September and early October. Three or four one-day workshops have been held throughout the October-December interim. With the second semester of the 1990-91 academic year underway, workshop meetings for each teacher/writer team have been set. A day and a half meeting involving all site coordinators, chief district administrators, and all SS&C staff was held to coordinate goals, schedules, assessment plans, and the nature of curriculum modules that are being produced. Depending upon the number of district teams involved, one to three modules are planned at each site. Enough experience is assumed on the part of all 6th and 7th grade teachers that a tentative Scope and Sequence for these levels is anticipated by the close of the 1990-91 academic year. This will permit major writing to occur during the summer as final plans for grades 6 and 7 are developed and initial plans and materials begin for grade 8.

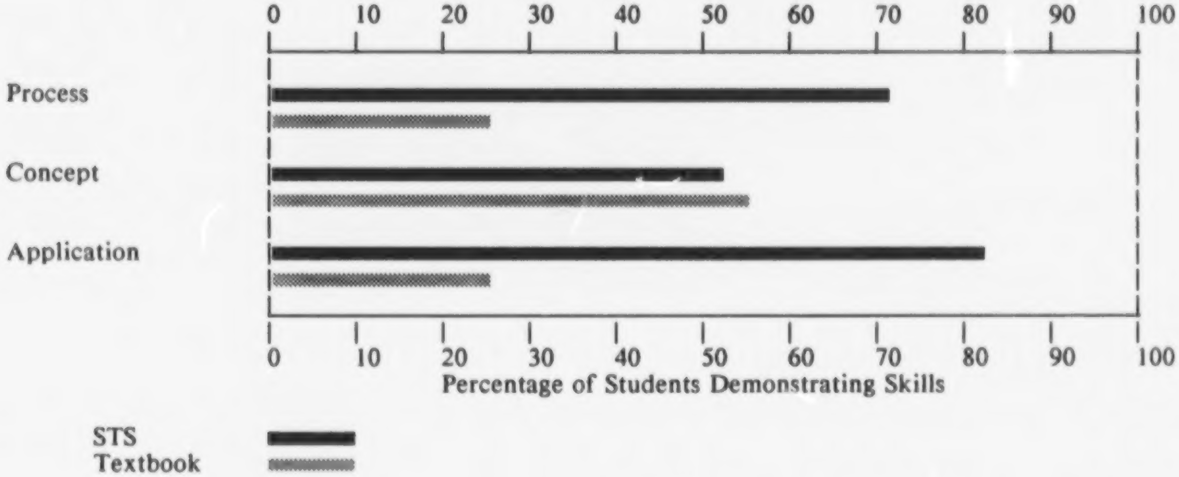
The Project 2061 themes, namely Systems, Models, Constancy, Patterns of Change, Evolution, and Scale (AAAS, 1988) have been endorsed for the Iowa STS modules. There will be an attempt to illustrate all six themes in each of the modules while one or more may receive the most attention in a given module.

Several Lead Teachers associated with the Iowa SS&C Project agreed to collect pre- and posttest information in all five assessment domains, including concept, process, creativity, attitude, and applications and connections. Initially one class section was chosen where textbooks were used exclusively and one where issues were used as curriculum organizers (STS). The assessment instruments are included in the latest Iowa Assessment Package for the Chautauqua Program (Yager, Blunck, Ajam, 1990). This package includes samples, test features, and scoring directions.

Lead Teachers from each SS&C site have provided pre- and posttest information on two sections of students in each of the five domains. Figures 1-3 provide the general results.

Figure 1

Skill with Science Processes, Science Concepts, and
Applications of Science Concepts when Taught with
A Standard Textbook Treatment versus STS Treatment



Process	(e.g., using space/time relations, inferring, selecting best experimental procedure, etc.)
Concept	(e.g., volume, motion, cell theory, energy, etc.)
Application	(e.g., identify questions, choose appropriate action based on new information, etc.)

Figure 2

Differences in Number of Unique Questions, Possible Causes, and
Predicted Consequences for Students when Taught with
A Standard Textbook Treatment versus STS Treatment

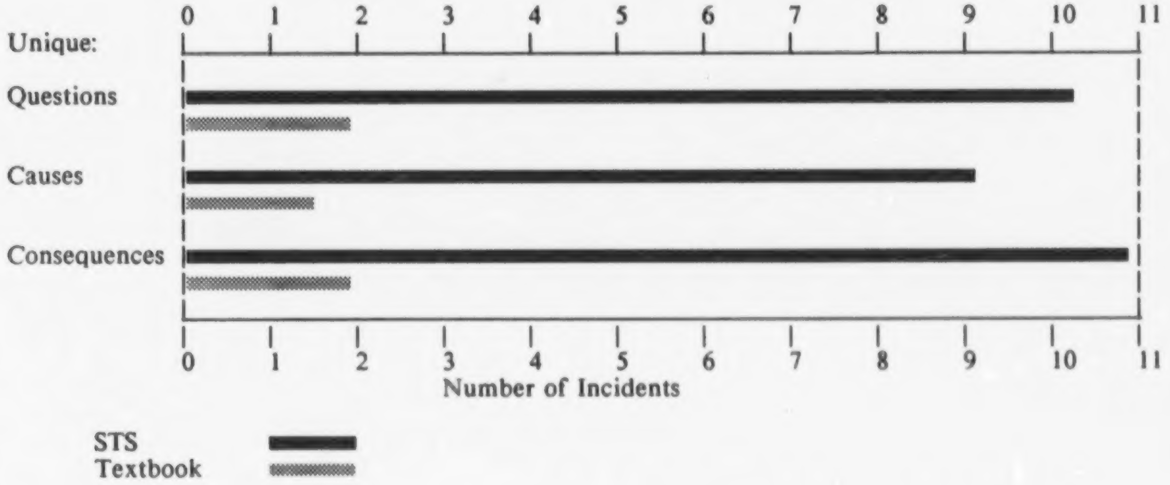
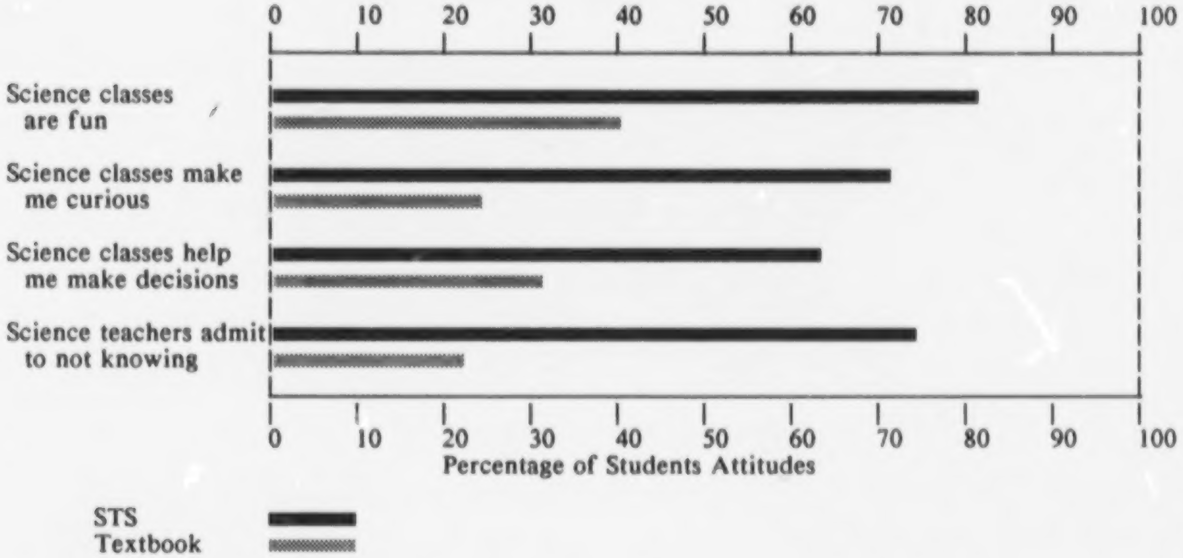


Figure 3

Differences in Student Attitude when Taught with
A Standard Textbook Treatment versus STS Treatment



Figures 1-3 indicate that STS students can demonstrate knowledge of as many basic concepts as students who concentrate on the mastery of concepts and terms which are the focus in the textbooks. But, STS students out perform the students in textbook sections in all other domains. STS students have many more positive attitudes; they score better on process measures; and they can apply the concepts to new situations which almost never occurs for students who focus on textbook coverage as the basis for their science experiences. The greatest difference, however, is in the area of creativity skills. STS students question more and they develop more skills with forming more unique and more useful questions. STS students are better at suggesting possible causes for certain observations and similarly those suggested are judged to be more unique and useful. Also, STS students are better at proposing consequences for certain actions or situations; again the consequences proposed are more useful and/or unique.

STS as defined by NSTA is producing student growth in domains where standard textbook experiences rarely produce any positive growth. The basic question remains as to the importance of growth in the domains other than concept mastery. If education and the public continue to glamorize scores on standard achievement measures, the real advantage of STS initiatives will not be observed.

One needs to ask if the goals for science education for all coincide more closely with all the domains or if we can continue to assume that existing measures are adequate to assess success with school science. STS seems to offer clear advantages over textbook teaching. Are these advantages desirable? The initial SS&C efforts clearly indicate that they are achievable.

REFERENCES

American Association for the Advancement of Science. (1988). Project 2061: Education for a changing future. Washington, DC: Author.

American Association for the Advancement of Science. (1989). Science for all Americans: A Project 2061 report on literacy goals in science, mathematics, and technology. Washington, DC: Author.

Blunck, S. M., & Yager, R. E. (1990). The Iowa Chautauqua Program: A model for improving science in the elementary school. Journal of Elementary Science Education, 2(2), 3-9.

Hart, E. P., & Robottom, I. M. (1990). The Science-Technology-Society movement in science education: A critique of the reform process. Journal of Research in Science Teaching, 27(6), 575-588.

National Science Teachers Association. (1982). Science-Technology-Society: Science education for the 1980s. Position Paper. Washington, DC: Author.

National Science Teachers Association. (1990). Science/Technology/Society: A new effort for providing appropriate science for all (The NSTA position statement). Bulletin of Science, Technology & Society, 10(5&6), 249-250.

Harms, N. C. (1977). Project Synthesis: An interpretative consolidation of research identifying needs in natural science education. (A proposal prepared for the National Science Foundation.) Boulder, CO: University of Colorado.

Piel, E. J. (1981). Interaction of science, technology, and society in secondary schools. In N. C. Harms & R. E. Yager, (Eds.), What research says to the science teacher, (Vol. 3) (pp. 94-112). Washington, DC: National Science Teachers Association.

Roy, R. (1985). The science/technology/society connection. Curriculum Review, 24(3), 13-16.

Yager, R. E., Blunck, S. M., & Ajam, M. (Eds.). (1990). The Iowa assessment package for evaluation in five domains of science education (2nd ed.). Iowa City, IA: The University of Iowa, Science Education Center.

A TRUE INTERDISCIPLINARY APPROACH TO STS

Steven Fleury, Department of Secondary Education (Social Studies)
Roger Hinrichs, Department of Physics
Carlton Salvagin, Department of Technology

State University of New York
College of Arts and Sciences
Oswego, New York 13126

The rhetoric of STS promises to transcend problems besetting the traditional school subject areas of science, social studies and technology. Yet, the linear organization of these subject areas, reinforced by pedagogical traditions and ideologies, provides a formidable context for the successful infusion of a process and issue-oriented STS program. Teachers who wish to implement an STS program work in an educational environment that emphasizes standardized testing as a means to measure student achievement within traditional subject boundaries. The sanction of testing in school settings encourages science, technology, and social knowledge to be viewed as separate bodies of objective facts, with little conceptual bearing on each other. Recent summer STS Workshops at SUNY Oswego have attempted to provide a true model of an interdisciplinary, process approach for middle school science, social studies, and technology teachers.

Three characteristics of these Workshops have reinforced the interdisciplinary process emphasis of an STS approach: (1) in-depth analysis of the foundational dynamics of science, technology, and society before developing curriculum materials, (2) having teams of teachers from all three subject areas develop a unified approach for their schools, and (3) instruction provided by a team of personnel - one from physics, one from technology education and one from social studies.

Discussions, presentations, and activities about the foundations of science, technology and society are premised on the idea that science, as a way of knowing, is inextricably tied to democracy. Public education is founded on the ideal of preparing citizens to pursue truths through public means, a pursuit common to science and democracy. Yet, the evolutionary structuring of the school curriculum in the twentieth century has severed this link. Deuschl (1988) points out that school science is taught as a set of "objective" facts, conveying to students an erroneous sense of absoluteness and certainty about the world. Swift's (1988) findings that high school biology students need to learn eight new science vocabulary words each school day in order to meet the objectives of the New York State Education Department suggests that school science is not promoted as a way of thinking, but as an accumulation of "thought-products."

In the social studies, the study of science as social phenomena is omitted. Along with the relegation of technology to mainly "occupational" related courses, students are easily led to believe that science, technology, and social knowledge are unrelated. The impression that arbitrary divisions of human knowledge are natural and apriori conceals how the school curriculum contributes to the stratification of society.

At Oswego, science, social studies, and technology teachers worked as teams during the week-long Workshops. The sharing of perspectives as a result of their group activities and discussions increasingly revealed to them the conceptual linkages of the three subject areas. Participants report this as one of the most outstanding aspects of the Workshops.

The participants' awareness of the problematic relationship between science and society was enhanced by introducing the Workshop with a panel comprised of a philosopher, an historian and a social studies educator. Subsequent to the panel discussion, participants were involved in group activities to "define" STS by focusing on these foundational dynamics.

An analysis of specific STS issues occurred daily, following the presentation of an invited speaker about a current STS problem. In preparation for these presentations, participants selected two significant assertions from their assigned readings, and posed two questions for each. This active preparation generated highly conceptual questions for addressing the quest speaker and facilitating the ensuing discussion about the topic.

At the end of a week of technical, political, and philosophical presentations and discussions, the teams of teachers explored ways to apply unified STS concepts and activities to enhance the objectives of their own specialized areas. Although the Workshops were brief, the activities contributed to our objective of allowing participants to use their specialized content backgrounds, rather than be restricted by them. Teachers from different areas began to see the relevance and universalness of some concepts of STS.

The STS Workshops began through a previously established Institute in Energy Education at SUNY Oswego. Historically, in 1983 exploration began in cooperation with local industry about ways to improve education. A "Math/Science/Energy Center" was discussed through the mutual efforts of personnel from two utilities and the college. Although the Center itself was never established, a smaller Institute in Energy Education was budgeted in 1984, with major funding coming from the two utilities. (Since that time one of the utility sponsors had to withdraw due to financial considerations.) The Institute centered its efforts on energy education through the training of secondary school physical science and technology education teachers. The subjects covered during the Institute dealt with a broad range of energy-related topics, with many hands-on activities, laboratory experiences and field trips. Over the last seven years, about 170 teachers have been "serviced" and over 130,000 students have been involved in improved educational experiences using the materials developed during the Institute. Some of the topics dealt with the impact of science and technology upon society, but little was done to specifically include social studies.

In 1989 a proposal was made to the funding utility (New York Power Authority) to establish an STS Workshop that would run concurrently with the Energy Institute. Such a format would allow us to keep costs down and use some of the speakers already committed to the Institute. As mentioned above, this Workshop would include STS topics and social studies teachers. The proposal was based upon the very impressive performance and successes of the Energy Institute as well as the fact that the sponsor would be helping meet new goals proposed by New York State. Questions were raised at this point during our negotiations with the utility whether some topics could be viewed as too sensitive to be covered (such as low-level radioactive wastes). However, the Energy Institute had set a precedent for insisting on the freedom to discuss any energy-related topic that seemed best for the educational purposes of the Institute. These discussions led the sponsor to understand that we were developing an approach, a set of skills and educational tools. Such skills would give teachers the opportunities to change their focus from past achievements and factual material only to the use of that knowledge and those skills in planning for the future. Consequently, funding commenced in 1989.

The development of the STS Workshop began from a "bottoms-up" perspective. We talked with personnel from the New York State Education Department and county teacher's centers, secondary teachers, and chairs in science, technology and social studies of two school districts. Our goal was to select a model district and work towards the integration of STS-type programs in that district at the middle school level through the modules developed during the summer. It was found that the social studies chairs were less receptive to this idea than those from the other two disciplines, primarily due to their perceived tighter schedule and the amount of new material that they had to cover. We continue to have dialogue with all three disciplines and feel that this integration will develop as more teachers have the experience of STS in a true interdisciplinary setting.

A key ingredient in planning the Workshops has been active, rather than passive, participant involvement. Although guests lectured on nuclear waste disposal, acid deposition, solid waste and landfill design technology, lectures by workshop personnel were kept to an absolute minimum by enlisting discussion, reaction and interaction. The primary intent was to impart to the participants the absolute necessity to adopt active learning methodologies in their own classrooms.

Each activity was structured to instill awareness, facilitate analysis and encourage involvement. One initial session addressed the objectives and content of the school curricular offerings. Specifically, "What is Science?", "What is Technology?", and "What is Society?". It is surprising how much teachers really do not know about the other subjects being taught by their colleagues in their own schools!

Another initial brainstorming session sought to establish a list of current world and national issues (see issues at end). From this list, specific topics were selected by teacher teams each composed of one science, one technology and one social studies teacher. Curriculum content, methodologies, strategies and student activities were then developed and shared with all participants.

Teams were also enlisted to participate in a "What if..." activity where a specific problem or scenario is listed in the center of a large sheet of paper. Spokes of a wheel are then radiated out to results or reactions that might occur if the problem were to continue. For example: failure to become involved in recycling (the identified problem) could result in water pollution, air pollution, full dumps, a new landfill near your home, higher costs for raw materials used to make steel, aluminum, plastics, etc., depletion of natural resources, etc.

Residential and school trash analyses, tours to the FitzPatrick Nuclear Power Plant, the Energy Recovery Facility and the county landfill all contributed to valuable, active, teacher involvement while participating in a truly integrated interdisciplinary learning experience.

Science/Technology/Society

WORLD AND NATIONAL ISSUES

Waste disposal
Recycling
Radioactive wastes - high & low levels
Ozone depletion
Global warming
Declining fossil-based energy resources
Toxins - air & water
Rate of technological development
EMF near electricity transmission lines

Population density
Water resources
Food resources
Financial resources
Biotechnology
AIDS
Drugs
Acid rain
Land use
Species extinction

References

Deuschl, R. A. (1988). Abandoning the scientific legacy in science education. Science Education, 72(1), 51-62.

Swift, J. N. (1988). The tyranny of terminology. Science Teachers Bulletin, Volume LI (2), 24-26.

INTRODUCING ENGINEERING AND TECHNICAL SUBJECTS ACROSS THE DISCIPLINES AT THE HIGH SCHOOL AND MIDDLE SCHOOL LEVELS: NSF SPONSORED INTERDISCIPLINARY SUMMER INSTITUTES

Edward Jay Pershey
Director, Tsongas Industrial History Center
Boott Mill, Foot of John Street
Lowell, MA 01852
(508) 459-2237 FAX (508) 459-3611

"...I feel as though I have walked through a door and entered an academic world that I dreamed about but never considered possible."

This is one of but several comments which appear in a formative evaluation report for a project titled "New Perspectives for Teaching the History of Science, Technology, and Industry in the High School." Administered by the Tsongas Industrial History Center at the College of Education, University of Lowell, through a grant in Science Education from the National Science Foundation, this two year (89-90) project brought together high school teachers of science, mathematics, technology education, and history to find ways of using topics from industrial history to encourage their students to study science and technology in a social context.

The Tsongas Industrial History Center is a joint museum education project of the University of Lowell and Lowell National Historical Park (National Park Service). In 1991 it will open a hands-on history museum dedicated to topics drawn from industrial history, and science, technology & society.

The important role of museums and informal science education in encouraging young people to choose to study science and engineering is becoming more apparent. The Office of Technology Assessment for the U.S. Congress in a 1988 report stated:

> *Although impossible to quantify, influences of families, friends, the media, and other aspects of the society on students are probably as great as those of the schools. The out-of-school environment offers opportunities to enhance students' appreciation of science and mathematics or to give them "second chances" in these areas, regardless of test-determined abilities. Programs outside of school can be both alternatives and complements to school activities....Some students are intimidated by science. Non-school and community-based programs, including science centers and museums, can awaken interest for these students, without raising the specter of failure.*

This also holds for teacher training and enhancement. The two-year project put teachers into a non-school, museum-like environment for three weeks. This change in venue stimulated new perspectives and approaches and encouraged study outside of the individual's chosen discipline. One of the goals of the project was to encourage teachers to emulate out-of-school approaches within their classrooms and curricula.

The basic approach in the NSF project was the infusion of topics related to science and technology throughout the high school curriculum. Interdisciplinary projects in high schools are very difficult since high school curricula are very discipline oriented and class scheduling does not lend itself to cooperative ventures between teachers of different disciplines. The experience of the Tsongas Center to date in working with high school teachers points to much more rigidity between the disciplines than in the university setting, perhaps, indeed, due to the much more rigid daily and school-year schedule. Hence the project took what can better be called "cross disciplinary" approaches.

In this cross disciplinary model teachers from different disciplines, hopefully working in concert with their colleagues down the hall, used topics drawn from the history of science and technology to teach their own disciplines, giving them the opportunity to add new stories, examples, and details to their own lessons. For example, a mathematics teacher in the project is used demographic and statistical data from the industrial development of the textile industry in Lowell as raw material for his lessons in computer literacy and computer use. His target was computer use, but also he also brought some real world data to bear and ended up teaching a little history in the process.

If a mathematics teacher is given the opportunity to work with the teacher covering US history, then this data can transferred to another class. Worked up into tables and graphs, sorted in various ways, this data can provide for the history teacher some impressive numerical and graphical evidence. Otherwise boring and seemingly impersonal assertions about broad socio-economic change in American society can be displayed as trends in demographic data. For students in Lowell such data connect historical trends to the local history of their own community and possibly their own families, something which history texts, with their generic approaches, can never attempt.

What the project offered to the participants was a solid three weeks, and for a core group, two school years of continued contact with colleagues from other disciplines. It also encouraged new perspectives on their own teaching. It did not encourage or expect wholesale curriculum revision. With mandated curricula and increasing expectations from school boards and administrations, teachers feel immensely pressured to cram as much into their courses as possible. Rather, the project and the Center tried to show that within a given curriculum or course there are numerous opportunities to use new topics and themes. If these topics are taken from the history of science and technology, then there opens up many possibilities for cross disciplinary work. There is also the opportunity to make connections to issues in the students' contemporary technological society.

Students disinterest in school in general and particularly in science and technology often stems from a feeling that the information being conveyed has little practical use. By connecting their everyday life and surroundings to any course work, the teacher has the opportunity to show the real connections. There is also the chance to give the students an opportunity to use their intuitive knowledge of how modern technological society operates to solve problems in school work.

The Tsongas Center brought to this project ideas and techniques from a specialty area of historical studies called "local history." The study of the history of the local community provides powerful ways of engaging students (regardless of age or grade) in a study of history in general. Starting with familiar names, places, things, and events, students who research the related history find that the stories which develop involve them, their families, their friends and neighbors in ways which traditional history texts do not. Particularly when challenged with researching artifacts and unusual topics, such as old factories or their parents' employment, the students are drawn into the stories of history in ways they least expect. Instead of reading history, they end up doing history, and find that history is active...maybe even *fun*!

Extending this approach to other disciplines can do two things. First, this new academic energy can be diverted to, say, computer literacy. Second, the connections which exist in the real world--between technologies and people, between mathematics and running a business, between physics and the protest against nuclear energy in their community--can be brought into the classroom. With this model students are likely to hear their mathematics teacher talk knowingly about local history and use that information in class, or their history teacher bring physics into American history, or a technology education teacher use on basic mathematics to solve some real problems in building a machine. At some point the "why do we hafta know this stuff" question may end up with some new answers.

The project conducted two three-week summer institutes at Lowell on specific topics in industrial history. The first, held in 1989, focused on the history of energy use and power production in the United States. The second in 1990 studied the development of transportation technologies.

The institutes were structured as a combination of lectures, discussion groups, readings, curriculum development, and field visits to historic and contemporary sites related to the topic. For instance, in 1989 the institute participants visited 19th-century water power sites in Massachusetts and Rhode Island, modern hydroelectric facilities on the Merrimack River, and ended up with an all day behind-the-scenes tour of the infamous Seabrook Nuclear Power Station (which 9 months later has begun regular power operations).

In 1990 the institute on transportation in American society had the opportunity to observe several active transportation facilities:

- Boston & Maine freight and maintenance facilities in Ayer and East Deerfield, MA
- Massachusetts Bay Transportation Authority operations and maintenance in Boston
- UPS transhipment facility in Chelmsford, MA

- FAA regional traffic control in Nashua, NH
- Lawrence Municipal Airport, with visual flight rules only

The emphasis in each case was on transportation technologies as interconnected systems and the underlying service technologies needed to maintain that system. The history of technology emphasizes the study of technology from this systems viewpoint, including in the idea of systems the cultural and social context as well.

The institutes were modeled on the best of adult learning techniques. The end mix of activities resembled closely graduate school seminars, with healthy interchange of ideas between participants and faculty.

For instance in 1990 a faculty member from the Mathematics Department at the University of Lowell lead the group through the use of Minitab, a statistical analysis package from Addison-Wesley. Data from Statistical Abstracts of the United States and from historical studies of transportation in America (such as George Taylor's The Transportation Revolution) were entered into Minitab format and were used as case examples during the sessions. These sessions were held at Lowell High School's computer lab, outfitted with Wang personal computers. Each participant received a copy of Minitab (MS-DOS version) to work with and take back to school with them.

Faculty for the summer institutes came from the University of Lowell, University of Massachusetts at Boston, University of Virginia, Brown University, and Harvard.

The topics for the summer institutes were selected by a group of ten local Massachusetts "core teachers," named in the grant proposal, who work together as a sort of management team for the grant. In the spring of 1989 they developed the topic, reviewed reading materials, set up a daily syllabus, and previewed site visits for the summer. Then in the summer they were joined by 20 additional teachers from across the country for the three week institute. Members of the core group made presentations and set up particular sessions during the institute. After the institute they evaluated the progress of the project and selected the next year's topic.

During the intervening school year this same core group developed individual and team projects ranging from interdisciplinary studies of mill architecture to the introduction of CAD systems into high school technology education courses:

- a physics teacher from Burlington High School developed short sections for use in his Advanced Placement Physics and Chemistry classes on "Generation of Electric Energy for Public Use," "Rotational Motion" (using a video of the historic Suffolk Mill turbine at Lowell), and "Thermodynamics" (using readings from the 1989 institute on the development of heat engines, specifically gasoline and diesel internal combustion engines)

- Lowell High history teachers expanded their Lowell History course to include extensive information on the technical aspects of mill design and textile production
- Computer instruction at Lowell High now uses data from the long history of textile production in the Lowell mills, including employee data, as raw material for database and spreadsheet instruction

During the winter and spring of 1990 the core developed the summer syllabus on transportation. Members of this core group also took a leadership role during the institute by preparing and making presentations, leading reading discussions, or preparing hands-on workshops. They were joined during the summer by a second group of 20 different teachers from across the country.

Both summer institutes proved highly successful in introducing technical topics to social studies teachers and in giving science and technical teachers an opportunity to view their disciplines in a broader social context. The professional collegiality engendered in the institute was, if not a new experience for all the teachers, an unusual opportunity for the teachers to interact with colleagues across disciplines.

The empowering of teachers in the NSF project is emulated in the Tsongas Center's "Educators Advisory Board" which meets monthly during the regular school year. About 25 educators from schools within a hour's drive of Lowell serve as advisors to the Center on the matter of exhibit, program, and curriculum development. Here, too, in the early meetings of this board teachers felt uncertain that indeed the Center really wanted their ideas and input. After several meetings, however, and the Center's plans and programs began to reflect the Board's work, it became clear that the staff of the Center meant what it said about listening to teachers' ideas and concerns.

Over its first two years of development, the Tsongas Center takes great pride in its track record of working in a collegial way with many different teachers. In December, 1990 , the Center received its second NSF teacher enhancement grant. Modeled on the first high school project, this second project is structured for middle school teachers. Summer institutes are planned for 1991, 1992, and 1993. The core of this new project remains, however, teacher-oriented and teacher-based, reflecting the Center's commitment to the idea of practical teacher empowerment.

Sources cited or mentioned:

U.S. Congress, Office of Technology Assessment (1988) Scientists and Engineers, Grade School to Grad School. OTA-SET-377. Washington, D.C.: U.S. Government Printing Office.

George Rogers Taylor (1951). The Transportation Revolution, 1815-1860. Volume IV, The Economic History of the United States. New York: Rinehart & Company.

THE ILLINOIS RIVERS PROJECT

Robert A. Williams, Ph.D.
The Illinois Rivers Project
Southern Illinois University at Edwardsville
Box 1122
Edwardsville, IL 62026
(618) 692-3788

Marylin Lisowski, Ph.D.
Department of Elementary Education
Eastern Illinois University
Charleston, IL 61920
(217) 581-5728

Kim Niemietz, Project Coordinator
Illinois Rivers Project
Southern Illinois University at Edwardsville
Box 1122
Edwardsville, IL 62026

Introduction

Much attention recently has focused on the impending crisis facing the state of education and of the environment. Specifically, the problems that are manifested in document after document note the lowering of scientific literacy by American science students at all levels; others show that the tolerance levels for survival of living things along our greatest river, the Mississippi (and its tributaries), have reached an all time low. The simplest science and mathematics problems often pose insurmountable difficulties for today's students. At the same time, students who live next to the "Father of Waters" are unable to eat its catch due to increasing levels of pollution. In an effort to address educational and environmental concerns, the Illinois Rivers Project began a cooperative effort to save our rivers and at the same time address our children's scientific and environmental lifestyles. By using available scientific technology along with an existing computer network, this project incorporated the resources of selected high schools to begin the process of nurturing Illinois rivers. In the project, students gathered information by using chemical analysis, population sampling, cultural and historical analysis and by documenting their efforts through writing and filming.

Theoretical support for this project was not difficult to find. Documents such as Rutherford's 1985 report, Education for a Changing Future (better known as Project 2061 developed by AAAS), laid the blame for certain instructional problems on the methodology used by many high school teachers. Further documentation for this appeared in The Science Report Card (Mullis and Jenkins ,1988) which reported that both the content and structure of school science curricula are incongruous with the ideals of scientific enterprise. The findings presented in the Project 2061 document are consistent with the comments first recorded by the A Nation at Risk report that initiated the scientific community's self-evaluation. Subsequent and continuing evaluation of science programs, (Educating Americans for the 21st Century), as well as the State of Illinois program through which this program was funded, elicited similar responses and reported the problem's impact on the attainment of student's scientific literacy. A recent publication by the AAAS, The Liberal Art of Science: Agenda for Action stated that a "radical reform" must be undertaken from preschool through the university if people are to understand science and its influence on their lives.

Phi Delta Kappan (Fort, 1990), while highlighting scientific literacy, offered conceptual support for the Illinois Rivers Project in the statement, "The twin goals of achieving scientific literacy for all and encouraging excellence for the gifted are inextricably linked." While advanced science classes, consisting of second and third year students, are enrolled in the River Project, its very nature included a student population that is much broader. Student involvement spanned the additional curricular areas of social studies and English, thus assuring participation from students of all ability levels.

In terms of current topics for scientific study, the project's subjects, the Mississippi River and its tributaries, are under constant investigation. Jacques Cousteau's vessels and the Greenpeace *Rainbow Warrior* have made trips on the Mississippi to draw attention to the river's problems. The Illinois EPA has finished a Low Water Quality Study of River in the St. Louis Area and is beginning a seven-year study along the river. The timing could not be better. The river needs attention and study, and thousands of high school students need a focus.

Program Description

The Illinois Rivers Project was developed as an integrated, multi-dimensional Science/Technology/ Society pilot project designed to introduce water quality dimensions into Illinois high schools. The River Project involved high school science, social science, and English teachers in an integrated study of their local river and community. Science students conducted water quality tests; social studies classes evaluated the culture and historical impact of the river; and English classes processed the information into a collection of writings that spanned all aspects of river life: past, present, and future. A key feature was the use of technology in the form of a computer network. The participating schools were able to communicate with each other via computer on water quality data, problems, and successes.

Specific goals addressed in the program:
1. Provide a working model so that Illinois high schools and middle schools can develop a science/technology/society unit based on water quality studies.
2. Provide equipment and materials that represent the available technology in scientific water quality studies.
3. Develop a vehicle for gathering data and applying skills gained in the social sciences (regarding water quality) to decision-making in real-life situations.

4. Interpret written materials on river life and culture in such a way that students will be able to write well-organized and coherent materials for acceptance in the project publication, Meanderings.
5. Develop an increased competency in microcomputer application and its role in data analysis.
6. Introduce project high school students and teachers to academic and industrial scientists, along with their equipment, so that they become aware of work at the "cutting edge" of science.

The Illinois Rivers Project was initiated in 1989 and was funded by the Illinois State Board of Education Scientific Literacy Grant Program. The initial pilot program involved eight schools with 24 teachers and 380 students. Each of the eight initial project schools was required to complete four water quality samplings taken from the Mississippi and lower Illinois Rivers. The project also included several extended classroom activities. Many of these excursions were taken during field trips to the river banks; some involved visits by local industry; other outings were taken to water and river related industry and laboratories.

All eight schools assigned the students to collect river data of scientific, cultural, and historical significance. Telecommunication served a critical role in the program for disseminating the data collected by the students. Water monitoring data from nine water quality tests were collected by all schools. Testing was conducted on: dissolved oxygen content; fecal coliform; pH; biological oxygen demand; temperature; total phosphorous; nitrates; turbidity; and total solids. The test results were sent to Southern Illinois University at Edwardsville via modems provided by the project and then onto the University of Michigan computer system, CONFER. A total of 141 tests were run by all participating schools. All data were archived and will become part of the overall data being accumulated and transmitted to the U.S. Fish and Wildlife Service for analysis and storage.

Project Outcomes

In the initial year of the Illinois Rivers Project, several benefits were evident. The project impacted teachers, students, and the community. The teachers who were involved in the program successfully collaborated with their colleagues in an interdisciplinary manner. In many cases, the nature of instruction was also affected by offering increased opportunities to students for experiential learning and field excursions.

Significant effects of the program on the participating students were evidenced in changes in students' attitudes toward science, in the extent of their involvement in field-based learning and in the dissemination methods utilized to share their experiences in the program. The students researched a variety of cultural and historical components related to the Mississippi River. Their original research was compiled into a 250 page publication called Meanderings. Each of the articles was a result of analysis by the students of the local river culture and history. The students also presented the specifics of the program to other school audiences. Each of the eight schools visited four other schools located along the Mississippi River for the purpose of sharing information about the program and for recruiting new schools into the project. Thirty-four schools were visited over a two-day period, with half-day presentations at each school. Twenty-seven of these schools enrolled and completed training in August as the newest members of the project.

The program's influence was also witnessed in the community. Each school was responsible for public awareness and presented programs to local businesses, as well as school and governmental agencies. Press releases were issued regularly though the University News Service at Southern Illinois University at Edwardsville. Student stories on river-related projects became a regular feature in their local newspapers. Local television stations produced several reports on the students' testing of the river. One of the teacher's comments on the Mississippi was cited in the national magazine, Newsweek.

Program Evaluation

The program's effectiveness was monitored in several ways. Data were collected on student attitudes and measures were taken on student's knowledge of water quality parameters and techniques. A profile of the participating teachers was developed and an assessment of the instructional priorities of the teachers also was conducted. Tables and explanations of these assessments follow.

Conclusions

The Illinois Rivers Project is an exemplary Science/Technology/Society program that meets all the requirements for such programs as established by NSTA and by the AAAS Project 2061. Combining the science of the chemistry class in the study of the Mississippi and Illinois Rivers with the social studies and English classes allowed teachers and students to cross over traditional boundaries established by most high schools. Experiences of everyone involved with the project, including project staff, teachers, and students has been highly satisfactory. All participants have been captivated by the project and its many avenues.

The greatest strength of this project was its ability to empower teachers to teach to the level of their training and capabilities. The time is right for environmental issues to be explored; it is right for telecommunication to be the method by which the project communicates internally; it is right because Meanderings allows other disciplines to become an integral part of the project. One conversation with an English teacher began, "I'm so excited to be asked to become involved in a science project. I have been teaching environmental literature for years and this is my first chance to be involved in a real project." The River Project is not just a science project; it is a real life project, about one of nature's gifts, the river, near which all of these kids and teachers live. Its fate may be their fate as they both move through time together.

The project's success can be measured by the change in attitudes of both students and teachers. The large quantity of writings submitted and water tests performed attest to that. The copies of news releases, articles, and television coverages indicate widespread community interest, as did the project being selected as the recipient of one of three Merit Awards from the Illinois Chapter of the Soil and Water Conservation Society. The project has also been nominated by this chapter for a national award.

The apparent ease with which teachers were recruited to the project should indicate success, as does the fact that English and social studies teachers joined science teachers in the effort. In the second year of the project, not a single school dropped out. All of these successes occurred in a loose affiliation of schools whose commitment was not to the project as an administrative body, but rather to the ideology embraced by the project. The schools , with their teachers and students, have been given an opportunity to make a difference in their world. Furnished with the knowledge that good, creative teachers formed the backbone of the project, a few simple tools were given to them to complete the task. Along with the hard work and determination of these teachers and their students, through the students' research and writing, the string of high schools who have become "River Watchers" has grown from eight to 48 in one year. Is the project successful? Only when schools from Lake Itasca, Minnesota to Pilot Point, Louisiana begin watching the rivers will the goals of the project have been completely accomplished .

Implications

The success of the first year of the Illinois Rivers Project has been dominated in large part by numbers. The years that follow must bring a new kind of organization to the project. The development of a "river curriculum" must be completed, along with extended units in geography, biology, and historical research. Contacts with other organizations conducting similar studies should be maintained and increased. Closer attachment to the international GREEN Network at the University of Michigan is a must. Two essential facets of the project must receive continued funding. Without the computer network, SOILED NET, and the production of student writings in Meanderings, the project would resemble the often short-lived studies that run out of steam because they are without a long-range purpose.

By its very nature, this project has been both centralized and decentralized. For the project to continue, leadership must be developed in each state interested in establishing their own River Project . A site within each state will then take over the responsibilities of the computer network and Meanderings. Steps are currently being taken to establish headquarters in Minnesota, Wisconsin, and Iowa. The successful expansion of the River Project into other states forms the foundation of a workable dissemination model.

Assessment of Student Knowledge of Water Quality Techniques

In an effort to obtain baseline data on student knowledge of water quality concepts and techniques, a 24-item inventory was administered to all students (N = 380), prior to their involvement in the Illinois' Mississippi River Water Quality Monitoring Project. The inventory included items which focused on the water chemistry field tests which the students would be conducting during the program. Two items were included for each of the targeted tests. A complete listing of: the items; targeted skill or water testing techniques; and percent of students who responded correctly is in Table 1. As anticipated, low percentages of correct responses were apparent in the pretest. Although complete posttest data were not procured during the first year of the program, a concerted attempt to monitor student knowledge changes through pretest and posttest analysis is currently in operation.

Table 1
Assessment of Student Knowledge of Water Quality Techniques

Item	Technique/Skill	Percent Correct
1	Watershed information	82.5
2	Watershed identification	14.7
3	Monitoring	22.6
4	Monitoring	64.9
5	Sampling	36.0
6	Sampling	16.5
7	Dissolved Oxygen	14.7
8	Dissolved Oxygen	39.7
9	Fecal Coliform	58.4
10	Fecal Coliform	30.1
11	pH	33.1
12	pH	22.6
13	Biochemical Oxygen	36.8
14	Biochemical Oxygen	54.8
15	Temperature	35.8
16	Temperature	16.1
17	Total Phosphorous	14.6
18	Total Phosphorous	46.3
19	Nitrates	15.2
20	Nitrates	28.6
21	Turbidity	21.6
22	Turbidity	83.2
23	Total Solids	27.2
24	Total Solids	30.4

Student Attitude Data

An attitude inventory was administered to the students in a pretest and posttest manner. A semantic differential format was used to elicit student attitudes to representative facets of the Illinois" Mississippi River Water Quality Monitoring Project. The categories contained word pairs which related to the topics of: Mississippi River; Field Work; Folklore; the Outdoors; and the Environment. Each worked in their feelings along a five point continuum. The results of both pretest and posttest inventories and the degree of statistically significant change are presented in the following tables. All responses were coded and scaled with the number one (1) being the most negative and the number five (5) representing the most positive. Posttest results revealed a development of more positive attitudes for each of the five examined categories.

T Test Results of Student Attitudes

Mississippi River

Significant changes in students' perceptions of the quality and relevance of the Mississippi were evident. Positive shifts occurred in the posttest, registering that students indicated that the Mississippi River was healthy and clear. Posttest results also showed that the river was important.

Table 2
Mississippi River T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
2	F	60	1.50	.72	1.55	0.67	0.45
2	M	45	1.24	.52	1.60	0.83	2.87**
6	F	60	4.48	.77	4.68	0.62	2.35*
6	M	45	4.24	.88	4.55	0.72	2.10*
7	F	60	2.16	.94	2.56	0.92	2.84**
7	M	45	1.88	.74	2.46	1.07	3.83***

*	$p < .05$
**	$p < .01$
***	$p < .001$

Fieldwork

Most science courses do not have provisions for fieldwork. Because of this limitation, students could have negative attitudes toward fieldwork. In the pretest, some of the negative perceptions were stated. However, posttest responses showed significant changes in their views of fieldwork; seeing it as creative, relaxed, and safe.

Table 3
Fieldwork T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
9	F	60	3.40	1.07	3.61	0.95	1.56
9	M	45	3.22	1.22	3.53	1.10	1.53
10	F	60	3.31	0.96	3.73	1.02	2.80**
10	M	45	3.28	1.14	3.33	1.14	0.22
12	F	60	3.38	0.90	3.53	0.98	1.20
12	M	45	3.04	1.14	3.40	1.03	1.94*

* p < .05
** p < .01
*** p < .001

Folklore

Since legend and lore about the Mississippi River has historically contributed to the richness of the river, items soliciting students' attitudes about folklore were included. Posttest results showed that students found folklore exciting rather than boring, timely rather than untimely, and wise rather than foolish.

Table 4
Folklore T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
17	F	59	3.32	1.00	3.59	0.81	1.99*
17	M	45	3.37	1.21	3.20	1.17	0.96
19	F	59	3.12	0.75	3.10	0.69	0.13
19	M	45	2.68	1.04	3.04	0.99	2.11*
20	F	59	3.23	0.83	3.81	0.86	3.91***
20	M	45	3.26	0.78	3.24	1.15	0.10
24	F	59	3.42	0.95	3.37	0.88	0.39
24	M	45	3.00	0.88	3.45	0.90	2.38*

* p < .05
** p < .01
*** p < .001

Outdoors

Among the goals of the River Project was the intent that students begin to develop an appreciation of the natural environment. Progress toward that goal was demonstrated in the students' responses that identified the outdoors as beautiful rather than ugly and familiar rather than strange.

Table 5
Outdoors T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
29	F	60	3.55	1.12	3.38	1.07	1.03
29	M	45	3.35	1.22	3.75	1.06	1.89*
30	F	60	3.48	0.89	3.40	0.86	0.61
30	M	45	3.22	1.04	3.24	1.04	0.13
32	F	60	3.95	0.94	4.03	1.04	0.65
32	M	45	3.68	1.08	4.04	1.04	2.97**

* p < .05
** p < .01
*** p < .001

Environment

Positive shifts in students' attitudes toward the environment were also registered. The students indicated that they thought the environment was more certain than doubtful and was kinder than it was cruel.

Table 6
Environment T Test Results

Item	Sex	n	Pre	SD	Post	SD	t
33	F	60	3.05	0.91	2.85	0.88	1.45
33	M	45	2.48	0.89	2.97	0.98	2.83**
37	F	60	3.26	0.93	3.38	1.04	0.88
37	M	45	3.06	1.11	3.68	1.06	4.06***
40	F	60	3.15	0.82	3.36	0.84	1.61
40	M	45	3.11	0.93	3.33	1.02	1.43

* p < .05
** p < .01
*** p < .001

Student Attitudes Towards Subject Areas

Students' attitudes towards the subject areas of chemistry, social studies, and writing were determined using an instrument developed by Silance and Remmers, "Attitudes Towards Any Subject." This attitude test was administered to project participants using a pre/posttest format. Students were asked to respond to a series of comments related to each individual area: chemistry, social studies, and writing. Their individual score was the median value of their total responses.

T Test Results of Student Attitudes Towards Chemistry, Social Studies, and Writing

Students experienced positive changes in attitudes towards chemistry and social studies. Their attitude towards writing dropped slightly. The most significant change in student attitude was in chemistry. Results of the attitude pre/posttest are contained in Table 7 below.

Table 7
Student Attitude Towards Subject Area T Test Results

Subject Area	n	Pre	SD	Post	SD	t
Chemistry	**144**	**8.02**	**1.28**	**7.53**	**1.82**	**4.20*****
Social Studies	**120**	**8.08**	**1.28**	**7.92**	**1.57**	**1.32**
Writing	**100**	**8.22**	**1.07**	**8.27**	**1.16**	**-0.58**

* $p < .05$
** $p < .01$
*** $p < .001$

Teacher Profile
(percentages)

Table 8
Discipline Taught

n	Science	Social Studies	English
24	37.5	29.2	33.3

Table 9
Educational Background

BS/BA	BS + 15	MS	MS + 15	MS + 30
4.2	37.5	29.2	4.2	25

Table 10
Years of Teaching Experience

1-5	6-10	11-15	16-20	21+
8.3	8.3	25.1	33.3	25.1

Instructional Profile

Table 11
Experiential Learning Emphasis
(Percentage of Time Allocation)

0-10%	11-25%	26-50%	51-75%	76-100%
37.5	25.0	33.3	4.2	0.0

Table 12
Critical Thinking Emphasis

Very Weak	Weak	Moderate	Strong	Very Strong
0.0	4.2	37.5	50.0	8.3

Table 13
Application of Concepts Emphasis

Very Weak	Weak	Moderate	Strong	Very Strong
18.2	22.7	31.8	22.7	4.5

Table 14
Environmental Attitude Emphasis

Very Weak	Weak	Moderate	Strong	Very Strong
4.2	8.3	58.3	16.7	12.5

Table 15
Provisions for Field-Based Learning

Very Weak	Weak	Moderate	Strong	Very Strong
0.0	25.0	45.8	25.0	4.2

Table 16
Availability of Teaching Materials (Environment)

Very Weak	Weak	Moderate	Strong	Very Strong
17.4	43.5	34.8	4.3	0.0

Table 17
STS Emphasis of Teaching Materials

Very Weak	Weak	Moderate	Strong	Very Strong
4.2	33.3	54.2	8.3	0.0

Table 18
Career Orientation Emphasis

Very Weak	Weak	Moderate	Strong	Very Strong
4.2	33.3	37.5	16.7	8.3

References

AAAS. (1989). Project 2061: Science for all Americans. Washington, DC.

AAAS. (1990). The liberal art of science. agenda for action. Washington, DC.

Bybee, Rodger W. (Ed.). (1986). Science-technology-society: 1986 NSTA yearbook. Washington, DC: National Science Teachers Association.

Bybee, R. W., Carlson, J., & McCormick, A. (Eds.). (1984). Redesigning science and technology education. Washington, DC: National Science Teachers Association.

Friends of the Rouge River. (1987, 1989). Interactive Rouge River water quality project: High school water quality values. Dearborn, MI.

Fort, Deborah. (1990). From gifts to talents. Phi Delta Kappan, May, 664-671.

Garbrell, E. Jr., Crowder, J., & Callister, J. (1989). Earth: The water planet. Washington, DC: National Science Teachers Association.

Hurd, Paul D. (1985). A rationale for a science, technology, and society theme in science education. In Bybee, R.W. (Ed.) Science-technology-society: 1985 NSTA yearbook. Washington, DC: National Science Teachers Association.

Illinois EPA. (1989). Low flow water quality characteristics of the Mississippi River in the vicinity of St. Louis. Marion, IL.

Illinois EPA. (1988). Water: The liquid of life. Springfield, IL.

Illinois State Board of Education. (1986). State goals for learning and sample learning objectives. Springfield, IL.

Mullis, I.V.S. & Jenkins, L. B. (1988). The science report card: Elements of risk and recovery. Princeton, NJ: Educational Testing Service.

National Center for Improving Science Education. (1990). Summaries of reports. Washington, DC.

National Commission on Excellence. (1983). A nation at risk. Washington, DC: Department of Education.

National Science Board of Commission on Precollege Education in Mathematics, Science, and Technology. (1983). Educating Americans for the 21st century. Washington, DC: National Science Foundation.

NSTA. (1987). *Criteria for excellence*. Washington, DC.

Rutherford, J. (1985). *Education for a changing future*. Washington, DC: American Association for the Advancement of Science.

Silance, E. B. & Remmers, H. H. (1934). *An experimental generalized master scale: A scale to measure attitudes toward any school subject*. Purdue University Stud. High. Educ., 84-88.

Smith, Edward L. (1990). Implications of teacher's conceptions of science teaching and learning. In Rowe, M.B. (Ed.), *What research says to the science teacher - the process of knowing*. Washington, DC: National Science Teachers Association.

FIRE: FROM PROMETHEUS TO THERMODYNAMICS

Louis B. Rosenblatt, Ph.D.

The Park School
Old Court Road,
Brooklandville, Md. 21022
(301) 825-2351

It is my hope in these few pages to share with you the character of a course I have taught at both the high school and undergraduate levels (a syllabus and list of readings may be found at the end of this essay). At the same time, I would like to suggest the value of approaching issues in science, technology, and society from the broad, integrative perspective of the history of science.

With these two goals in mind, let me begin with a wonderful passage from an H.G. Wells novel, The World Set Free. Wells is speaking of life a quarter of a million years ago when the utmost man was a savage.

> He knew no future then, no kind of life except the life he led. He fled the cave-bear over rocks full of iron ore and the promise of sword and spear; he froze to death upon a ledge of coal; he drank water muddy with the clay that would one day make cups of porcelain ...

The irony which carries this passage is the juxtaposition of past and present, and our appreciation of the promise which lay trapped within iron, coal, and clay. But if we move from technology and material culture to the world of ideas, particularly ideas surrounding the nature of fire, the contrast is equally sharp. And there is an irony here, as well; though it is a more subtle matter, a matter of understanding and of empowerment.

For 2,000 years fire was a major analytical category of the sciences. Today, we would fail to find it in the table of contents of any science text of the sort one would find in a university bookstore. Fire is no longer a category. It is not an element of our understanding of nature. Furthermore, I daresay fire would not even appear in an index. It is not even a thing. Modern science has dis-mantled the flame and scattered the ashes. In one text we may study oxidation-reduction reactions. In another, we find black-body radiation. In a third, we find an introduction to statistical mechanics, and in still another a study of electro-magnetism. How often are these linked to combustion, incandescence, convection currents, or radiant heat and brought together in the dance of the flame? When this does not happen, have we any right to be surprised when our students fail to connect the science they learn in class and the world around them?

If I may digress for a moment, I discovered this for myself years back when I broke from a gaze into a fire to ask a friend what the glow of the coals was about. A physicist, he was soon talking about black-body radiation, and only then did I connect what had always been for me simply an introduction to quantum mechanics, a way of getting into Planck, with the phenomena of incandescence.

But there is more here than the dis-mantling of the flame. There is the dramatic difference in our understanding. Why had science for so long seen fire as a primal agent and material stuff? What sort of science did this understanding frame? And what has been at stake, as we have step by step forged new understandings?

In seeking the rationale behind this old framework, we stand the irony of Wells' passage on its head. The juxtaposition between past and present is still there, but now the task is to capture lost potentials. Having re-evoked in full measure the omni-presence of the flame, only then can we re-construct the modern understanding and dis-mantle the flame, one step at a time.

Thus it is, that our study begins with the legends of Prometheus, and we note how, for Aeschylus, Prometheus was not just the bearer of the flame, but stood as a symbol of all the gifts which technology and science had offered: agriculture, navigation, astronomy, letters, and arithmetic. Just as the flame itself was a transforming agent; so had the ancients understood that the mastery of the flame had been the centerpiece in the transformation of society.

The centrality of the mastery of fire in the emergence of society is suggested by a myriad of details (particularly relevant here is Frazer's The Golden Bough). One item, for example, which I find especially intriguing keys on the importance of the early communal fire. So important was the maintenance and safekeeping of this flame (and if you have tried the proverbial and most demanding rubbing of two sticks together you will appreciate why), that it may well have been the original stimulus for the notion of civic office --of communal responsibility. The greek words for public building and civic official both derive from the words for hearth and fire-tending.

The control of fire marked a technological revolution comparable to the development of agriculture. The mastery of the flame and of the forge had a profound impact on the human condition. First, there was the beating of both sword and plowshare, and all that they both imply. In addition, there was a shift in the way we understood ourselves. We became technological man --homo faber. We were now powerful agents, transformers and makers, not simply husbanders of nature's bounty. Until the early modern era, until chemistry and the mechanical sciences of the 16th centuries, this understanding was linked to a perception of nature strikingly different from our own. Nature was seen as alive and as sacred. The contrast here is absorbing, and students are drawn to this difference and what it tells us of ourselves. (If I may suggest in passing an analogous instance: consider the difference between the 19th century notion of bio-chemistry as the chemistry of life, and our modern notion of it as the chemistry of the carbon atom. A carbon atom is a carbon atom, and on that level life is not a boundary. Modern bio-chemistry does not even recognize living things.)

To continue, the first phase of the course evokes the centrality of hearth and forge for ancient mankind, and so sets the stage for the rest of our study --a study we may divide into three parts.

(1) The intimate connection of fire and technology. From the forging of sword and plowshare to the steam engine and the industrial revolution, the heart of the tale is the mastery of the flame. Especially important here is Eliade's The Forge and the Crucible, along with a number of works on modern events. One work, for example, I should like to make room for is George Orwell's The Road to Wigan Pier.

(2) The mystery of the flame, and the reverie which absorbs us as we gaze at its dance. Here the course opens to the meaning of fire in literature, in psychology, and in religious ritual. This part of our study is indebted to Bachelard's The Psychoanalysis [illegible] Fire, and draws upon such fine works as Faulkner's "Barn-Burning," Hawthorne's "Ethan Brand," and Frisch's Biedermann and the Firebugs. Wherever we turn, however, this aspect of the course is inevitably personal. It enlivens the rest of our study, and brings to it an authenticity which is striking and most valuable.

(3) The emergence of science and of systematic reflection on the nature of fire. We examine here the concept of an element, and trace through such controversies of a later day as those surrounding phlogiston and caloric, arriving in the end with the mechanical theories of the mid-19th century.

I should note here, as well, the importance of lab activities and the rich array of lab experiences this study invites, from: rubbing sticks together, examining candles, making thermometers, and the whole host of activities on latent and specific heats, mixing fluids and the conservation of heat, the mechanical equivalent of heat, spectra, radiant heat, even black-body radiation.

In closing, we may return to Wells' savage shivering upon a ledge of coal. Can we not match it with the image of the modern science student upon a ledge of texts? Is there not, all too often, the same failure to realize the potential that lies within? How many students do we have who know the earth is a planet, but do not have the least idea why? or students who take it there are atoms, but have no idea why we would think so? or students who would study the kinetic theory and later turn to the Periodic chart looking for Fire? I think a course such as the one I have shared with you is what those students need to come in from the cold.

I attach here a course outline and a list of readings surrounding "Fire: from Prometheus to Thermodynamics."

Sequence of Topics

1. Prometheus. Evoking the omnipresence of the flame --and its disappearance. Bachelard, Gilbert Murray, Encyc Brit entry.

2. M. Eliade, Forge and the Crucible. The impact of the mastery of fire on the human psyche. The sacred and the profane. Alchemy.

3. J. Morgenstern, Fire on the altar, fire and religion.

4. Lloyd, Early Greek Science. Origins of science in classical Greece. Parmenides, elements, Heraclitus. Popper, de Santillana.

5. Alchemy, back to Eliade, development of early modern chemistry. D.C. Allen, O. Hannaway, A. France.

6. Phlogiston and the science of the profane, rise and decline of material theory of combustion. Asimov, Guerlac.

7. Caloric and the physics of order, rise and decline of material theory of heat. Brush, Fox.

8. Herapath and early 19th c. physics, philosophy, and the science of disorder.

9. Conservation of Energy. Steam Engine. Industrial Revolution. Carlyle, Spencer, Tyndall, Briggs, Kuhn.

10. Age of the Sun, Kelvin vs. Darwin.

11. Entropy, Heat death, and the physics of chaos.

12. Incandescence, black-body radiation and the dawn of quantum mechanics.

Labs and Phenomena

Making a fire --candles --thermometer --latent heat and ice --mixing fluids, conservation of heat and specific heats --combustion and oxygen --Blacksmith's nail --mechanical equivalent of heat --steam engine --spectra --radiant heat --incandescence.

Readings in and around the course

D.C. Allen, *The Legend of Noah*.

G. Bachelard, *Psychoanalysis of Fire*.

Asa Briggs --a host of books, often well illustrated, on the industrial revolution.

Stephen Brush, *Kinetic Theory of Gases*.

Joe D. Burchfield, *Lord Kelvin and the Age of the Earth*.

J.B. Conant, ed., *Harvard Case Histories in Experimental Science* includes major essays on both phlogiston and caloric theories.

Mircea Eliade --several works on myths, symbols, and the sacred, including *The Forge and the Crucible*.

Michael Faraday, *The Chemical History of a Candle*.

Robert Fox, *Caloric Theory of Gases*.

James Frazer, *Golden Bough*.

Henry Guerlac, *Essays and Papers* includes several essays on Lavoisier and the phlogiston theory.

George Grote, *History of Greece*.

J.L. and B. Hammond, Lord Shaftsbury.

Owen Hannaway, Chemists and the Word.

Eric Havelock, Preface to Plato and Prometheus.

Robert Kargon, Science in Victorian Manchester.

Thomas Kuhn, "Energy Conservation as an Example of Simultaneous Discovery," in M. Clagett (ed.) Critical Problems in the History of Science.

A. Lavoisier and P. Laplace, Memoir on Heat.

G.E.R. Lloyd, Early Greek Science: Thales to Aristotle.

John Lyons, Fire.

J. Morgenstern, Fire on the Altar.

Gilbert Murray, Aeschylus.

Karl Popper --several works on the philosophy of science.

G. de Santillana, Origins of Scientific Thought

Theophrastus, De Igne.

Tyndall, Fragments on Science.

Fire and Literature

Isaac Asimov, "Nightfall."

William Faulkner, "Barn Burning."

Anatole France, At the Sign of La Reine Pedague.

Max Frisch, Biedermann and the Firebugs.

Nathaniel Hawthorne, "Ethan Brand."

George Orwell, The Road to Wigan Pier.

"TOO MUCH GARBAGE!"
-The Problems of Landfills, Groundwater Contamination, and Recycling-

Mark A. Brockmeyer
Earth Science Teacher
City High School
1900 Morningside Drive
Iowa City, Iowa 52245

A. DESCRIPTION

"TOO MUCH GARBAGE!" is designed to be the framework for a lengthy unit of study (10-30 days) in the earth sciences. The unit is based on an S/T/S (Science/Technology/Society) approach to science education, and could be used in upper elementary, junior high, or high school. Ideas, activities, and resources listed are those that worked well for the author. Teachers are encouraged to expand upon them, or change the direction of the investigation, based on their own situation and class. A local focus/problem is essential for the student to view the unit as relevant and meaningful.

Student input and direction are basic to the development of this unit. Throughout the investigation, student groups should be actively involved in determining the directions of study, activities necessary for further understanding, and social actions that they deem important enough to carry out personally.

Since the unit is centered around an interdisciplinary topic, the teacher is central in guiding the investigation. The concepts and principles which will be encountered throughout the unit can be clarified and reinforced by the teacher, based on the particular curriculum objectives established. The scope of this topic has the potential for encountering countless science principles and concepts which are to be studied. Ideally, this will provide an opportunity for students to see the interdisciplinary nature of "the real world" with the artificial barriers between subjects and chapters eliminated.

Throughout this activity examples of how this unit was developed at City High School are provided in italics. These sections should only be viewed as one example of how this unit might develop and not seen as specific directions for what should/will happen.

B. OBJECTIVES

1. The students will investigate a real world problem while identifying the questions and resources necessary for further understanding.

2. The students will work in cooperative situations to develop, and implement, a course of action to help reduce the problem that is identified by the class.

3. The students will be able to explain basic earth science concepts and principles, while applying them to real world situations.

   Examples: renewable/nonrenewable resources, porosity and permeability, rock types and characteristics, aquifer, contaminate, chemical compounds, biodegradability, compaction, recycling, pollution, landfill construction, etc.)

4. The students will have a positive attitude toward science classes and view them as relevant, meaningful, and useful.

C. INTRODUCTION

Identifying a Problem (1 Day)

Several articles related to the problem of garbage and contamination should be brought into class. Articles related to problems in the local area would be best. Each student will be given a copy of one the articles and instructed to take a few minutes to read their article. During the class discussion that follows, students are asked "What do you see as the problems?" The responses are listed on the board and finally, the class is asked to narrow down the list and to clarify, what is the big problem? When the class is in general agreement, the ''problem for investigation'' is listed on the board. This will provide the focus for the activities and investigations that follow.

> *With the variety of articles used (local landfill problems, articles on types of materials going to landfills, groundwater contamination, etc.) students at City High determined that all of the other problems were the result of a throw away society or simply too much garbage. ''Too Much Garbage'' became the central focus for the rest of our unit of investigation.*

Defining the Scope of The Problem (1 Day)

On the second day, a few minutes should be spent reviewing the list of initially identified problems and restating the major problem. Next, the class should be divided into cooperative groups of 3-4 students.

A. Half of the groups are given the assignment of listing all of the **ASSUMPTIONS** people make, that lead to the problem, or that people make about the problem. The list should be recorded by one member of the group.

B. The other groups are focused on identifying all of the **CONSEQUENCES** that result from the problem (or the actions associated with the problem), positive and negative. One member of each group should be selected to serve as recorder.

This brainstorming phase may take 15-20 minutes or more. Students should be encouraged to list all of the possible assumptions and consequences they can think of. **All input should be accepted and seen as potentially valuable!** As the brainstorming portion of the activity slows, it is time to create two lists on the board, (A) all of the assumptions and (B) all of the consequences. The class should come to a consensus as to which of the consequences are positive and which are negative. If more negative consequences exist, then it is still a problem.

Below are some of the responses that might be expected to emerge from this brainstorming session:

ASSUMPTIONS

- *there will always be more resources available*
- *it doesn't hurt me personally*
- *garbage isn't a problem*
- *someone else will take care of it*
- *when the truck takes it away, it's gone!*
- *it all breaks down*
- *we have to have all of those items*

CONSEQUENCES

- *we will run out of natural resources*
- *there won't be enough landfill space*
- *the water supply will become contaminated*
- *jobs are created to deal with the garbage*
- *more sanitary conditions by using things once and disposing*
- *it helps the economy*

Alternative Actions that Would Reduce the Problem (1 Day)

Now that the problem has been defined, and some of the major reasons for the problem (assumptions) and results of the problem (consequences) have been identified, it is time to look at alternatives.

Students, again working in cooperative groups of 3-4, are asked to brainstorm and list all of the possible **ALTERNATIVES** to the present situation. The key is to have the students list all of the ideas that they have, whether feasible or not. After 10-20 minutes, each group should report to the class and a common list of alternatives should be placed on the board. If possible, class discussion should be directed toward identifying any major categories of alternatives that exist.

Alternatives that might be included:
- *burn all of the garbage*
- *use rockets to send the garbage to the moon*
- *recycle paper, metal, plastic, etc.*
- *don't use as much stuff*
- *charge people more to dispose of it*

Students have found that the alternatives listed fit into three broad categories.

1. *Dispose of differently (burn it, send to moon, etc.)*
2. *Reuse it (recycle, etc.)*
3. *Don't use as much to begin with (different packaging, etc.)*

What do we Know, What do we Need to Find Out (1 Day)

Each small group of students is assigned one of the alternatives to investigate. During the period they are asked to analyze the proposed alternative four ways:

1. On what assumptions is the alternative based?
2. What are the social impacts of the problem and the alternative?
3. What are the economic and political impacts of the problem and of the proposed alternative (who will be affected and how)?
4. What evidence (factual data) do we have related to the problem and the alternative?

Near the end of the period, groups are asked to report briefly on what they have done. At this point, students have a pretty good idea of what the problem is, some of the causes of the problem, and what might be done to reduce the problem. Students realize however that they have very little **evidence** to support their position and that more research is needed.

The activity sheet that was used for this process included sections to list assumptions, social impacts, economic and political impacts, and evidence known at this time. Students found this to be quite useful for organizing their information and evidence (most of which will be collected later).

D. INVESTIGATION

Researching the Problem and the Alternatives (2-5+ Days)

For two or more days the class is involved in gathering information that will help them to understand the problem and to make some informed decisions regarding their proposed alternatives. This could involve any number of things, including library research, contacting guest speakers, arranging field trips, calling local businesses, or sending letters for more information.

Students should be actively involved in defining their own questions and in identifying where they can go to find out more. Most of this work can be done on an individual student basis, with the student deciding what aspect of the problem or the alternative that she/he wishes to investigate further. For many this will involve looking at the alternatives that they looked at on the previous day. Students should be allowed to look at some other aspect of the problem if it would be of greater interest or concern.

> *The investigation at City High, to find out more information on the problem and the alternatives, included:*
>
> *-gathering magazine articles related to the problem.*
> *-contacting the local landfill operator for information.*
> *-arranging a guest speaker from the Department of Natural Resources.*
> *-ordering films and videos related to landfills and recycling.*
> *-looking through earth science books to find information and activities related to aquifers and groundwater.*
> *-telephoning government hotlines (groundwater contamination).*
> *-making diagrams and posters.*
> *-analyzing ''personal garbage'' to see what people throw away.*
> *-analyzing the school garbage.*
> *-creating student surveys to see if their assumptions about student attitudes were correct.*

Investigating the Problem as a Class (10+ Days)

Over the course of the research phase, the evidence is constantly being added to the class list on the board or overhead (a class ''data base'' can be established somewhere in the room, with key evidence and information being listed and shared with the rest of the class). The problem is often redefined and new alternatives are proposed and supported with data. Students will become much more critical of ''reports'' and ''personal opinions'' and instead ask for evidence and implications. As a class, information is shared, speakers are brought in, activities are developed and carried out, films are viewed and articles are read.

Science concepts and principles are constantly being encountered in class, with students providing the explanations to other students or students asking the teacher to provide definitions or explanations. Suddenly, information is being learned because the students need (and want) to know more so that they can better understand the problem.

> **Although the teacher will want to have some resources and activities available, they will be surprised at how many things the students will come up with. Over the course of the investigation phase, students:*
>
> *-listened to a guest speaker from the Dept. of Natural Resources.*
> *-conducted various experiments related to aquifers/contamination.*
> *-developed group presentations.*
> *-viewed films that students had selected and ordered.*
> *-read current newspaper and magazine articles.*
> *-conducted class discussions related to pros and cons of alternatives.*
> *-used the Earth Science text as a resource for information.*

E. SOCIAL ACTION

Doing Something About the Problem - Social Action (5-10+ days)

In light of the new evidence and the redefining of the problem and the alternatives, it is time to ask the class - ''What can we do about the problem?''

During the previous 3-4 weeks, the students will have thought of a number of ways in which they might help to reduce the problem. The solution(s) that the class finally decides to implement can be anything from a personal behavior change to a major school/community/state campaign. Encourage the students to think of a variety of actions and support their proposals with evidence.

Developing and implementing a plan of action is perhaps the most important objective for this unit. To this point the students will have learned a great deal about the problem from a social perspective and the science and technology associated with the problem and the alternatives. What remains is for the students to demonstrate what they have learned, by using the information to make a decision, and take action!

> *Below are three ideas that resulted from this unit. Other classes may take some forms of action quite different from these.*
>
> *1. School Paper Recycling Project - Students discovered that over 40% of all material going to a landfill is paper. Each day City High disposes of large amounts of paper, most of which is able to be recycled. With this in mind, the students*

developed a written proposal for recycling paper at City High School. The proposal was submitted to the administration, faculty, and student senate for their endorsement. Boxes were placed in over 60 classrooms and offices, for the collection of waste paper. The project is ongoing, with all proceeds from the recycled paper going to other environmental projects at the school.

2. *Plastic Milk Jug Collection Contest - Iowa City has a program in place to collect plastic jugs for recycling. Students discovered that a majority of people were unaware of the program and that they did not recycle their plastics. In an attempt to improve awareness, they decided to hold a contest for two weeks to see how many milk jugs could be collected and brought to school for recycling. Throughout the contest, the student body was made aware of the community recycling project, and informed of the locations around town where jugs could be delivered. The main goal was to increase community awareness of the existing project and, if people recycled their plastics for the contest, perhaps they would continue to do so after the contest was over.*

3. *''Second Chance Booklet'' - What seems like garbage to some people might be a useful resource to others. Students determined that many things that are thrown away after one use could be used for something else. The students created a booklet with over 60 ideas for reusing cans and containers. Ideas ranged from the common uses, like making a pencil holder out of an aluminum can, to complex crafts and toys. The booklet was copied and distributed to students and staff in the school.*

F. EVALUATION

A wide variety of evaluation methods may be used with this unit. Teachers are encouraged to develop their own evaluation plan, using as many different methods as possible. Depending upon the types of activities developed, and the objectives established, a plan might include:

-participation and cooperation in small group work and class discussions.
-quizzes and tests based on the concepts and principles encountered during the investigation (knowledge recall, application, and process skills).
-student self-evaluations of participation and contributions.
-group evaluations.
-giving points for resources contacted/identified.

-giving points for participation in the action phase of the unit.
-keeping notebooks/journals that cover the investigation.

G. CONCLUSION

This plan only serves as an outline for a unit of study that must be developed locally, with teacher and student working together. A major factor in determining the success of any unit of study is the degree of ownership felt, by the teacher and the students.

> *Any comments and suggestions regarding this unit would be welcomed. In addition, directions of investigation and action that your students take, as the result of this unit, would be of great interest to the author.*

AN INNOVATIVE CAD PROGRAM

Joseph E. Ryan of the Hingham Public Schools
41 Pleasant St. Hingham, MA. 02043 617-749-2160

Off campus cooperative educational programs have long been touted as an excellent way for students to learn. The placement of students in such real-life situations is for them a new, exciting, valid, and eye opening experience.

However, if this assessment of cooperative education is accurate, then why are such programs seldom offered to the school's better students, that is, to academically motivated students who anticipate college careers? It is the opinion of the author that many students in cooperative programs are not academically motivated. It seems, to the author, that the bulk of cooperative students come from the ranks of the underachiever, many of whom school administrators would prefer to have out of the school building for as much time as possible.

Given the assumption that motivated students are under served by cooperative education, the author would like to describe a cooperative program he has implemented which complements a motivated students rigorous academic schedule. The author has selected a small group of high school seniors with skills with skills in computer assisted drafting, and placed them in an elementary classroom for two afternoons per week, having them teach their skill to these youngsters. These seniors, called interns, are by most measures, average hard-working students.

The elementary youngsters are academically gifted. Although gifted in that they have high abilities in math, science, and computer skills, each of these students is, at the same time, learning disabled. For educational purposes they are classified as Gifted/Learning Disabled or GLD. Some of the youngsters have deficient motor skills while others have emotional problems or difficulty organizing their thoughts. Although the difficulties vary, each youngster has an impediment to learning.

The primary goal of the program is twofold: to provide an off campus program for secondary students, and to augment the computer skills of the gifted youngsters. Although teaching a computer skill is the program's academic justification, its primary purpose is affective. It is the author's contention that the interns can make a greater impact on the youngsters development in ways that are not academic. The youngsters have progressed through most academic matters with ease and at a rapid pace. However, such devotion to scholarly matters often comes at the sacrifice of other childhood experiences. The interns will provide needed role models for these youngsters who are, by their nature, not ordinary children. What for example the interns teach about baseball, or the self-esteem related to baseball skills, could be more meaningful than what they teach about computers.

Designed and implemented as a case study, this study will operate in the author's employing school system for academic year 1990-1991. The interaction of the two groups will provide answers to the following questions, as well as raise questions that cannot be anticipated at this time.

BASIC QUESTIONS OF THE RESEARCH:

What are the personal, educational, and career benefits of an off campus learning experience for college bound students?

What are the particular problems of Gifted/Learning Disabled students, and how can public education better serve these students?

What impact will this project have on the cognitive skills, particularly those dealing with technological literacy, for the members of these two groups?

To what extent will the interns impact the affective development of these exceptional children who appear to have limited ordinary childhood experiences?

REFERENCES

Bell, D. (1975). Technology, nature and society. Edited by Hindle, B. The frontiers of knowledge. New York: Doubleday and Co. Inc.

Boyer, E. L. (1983). High school: a report on secondary education in America. New York: Harper Row.

Dyrenfurth, M. J. (1987). Technological literacy: more than computer literacy. (Report No. IR 013 756). Dallas TX. National School Board Conference. (ERIC Document Reproduction Service No. ED 305 901)

Hanley, T. V. (1987). Case study findings on the implementation of computers in special education. (Report No. EC 212 554). Alexandria, VA. (ERIC Document Reproduction Service No. ED 304 859)

Jones, B. L., and Maloy, R. W. (1988). Partnerships for improving schools. Westport CT: Greenwood Press.

Marshall, C., and Rossman, G. (1989). Designing qualitative research. Newbury Park, CA: Sage Publications Inc.

Merriam, S. B. (1988). Case study research in education. San Francisco CA: Jossey-Bass Inc.

Ryder, K. G. (1989). Cooperative education: a quiet revolution. Connection, (summer) 4 (2) 28-30.

Smalley, L. (1986). Technology education: from where to what? Bulletin of Science Technology and Society, (2) 188-194.

Yin, R. K. (1984). Case study research: design and methods. Beverly Hills CA: Sage Publications Inc.

MATH EDUCATION TODAY -- BEAR OR BULL MARKET?

Russell E. David
2 Capri Gate
Plainview, NY 11803
(516) 433-1117

"Every society is faced with the threat of being engulfed by a wave of barbarians - the next generation and somehow these barbarians must be converted into adult members of the social order. Normally this is done by parents, peers and formal agencies (schools)"
So dramatically does Prof Willard Waller tell us that the major task of our generation is to civilize the next. To paraphrase a famous ex-mayor, we must ask "How are we doing in Math education?" According to many articles in the press, it appears to be a definite bear market in Mathematics education. Examples are manifold. To cite a few of the most recent to bombard us:

The National Assessment of Educational Progress tells us that "only 16% of seventeen year old students could solve a multistep Math problem like "Christine borrowed $850 for one year at 12% simple interest. What was the total amount she repaid?"
In New York State the results from the Regents Minimum Competency exam only has 56.4% of all high school students achieving an eighth grade level.

The National Center for Educational Statistics claims that in 1983 one third of the dropouts said that they felt school was not for them and another third dropped out because of poor grades.

A teacher in New York City is quoted by Mr. Shanker in an New York Times article, asserting that his average student was absent 27 times and late 12 days in a term of 82 days.

The Educational Teaching Service reported that in 1989 our thirteen year old students had less Mathematical skills that similar students in South Korea, Britain, Spain, Ireland and four provinces of Canada.

So it would appear that Math education is in dire straits and in need of violent reforms to correct this bear market. However, in the same press, we can read completely contradictory statistics.

In the 1989 Math Olympiad, our six member team placed third among the 54 competing countries. China was first while the Soviet Union was second. Even more interesting is the fact that when we finished first in 1986, China sent educators to each of our members high school and copied the curriculum followed in each school. Even more amazing our team normally trains for three weeks before the competition while the Russian team starts one year before.

The American Council on Education states that from 1978 to 1988 the only country that increased the High School graduation rates (from

80.7 to 81.2) was the United States. In addition, college attendance rose in this country from 31.4 to 37.2 over the same period.

According to Michael Mc Laughlin in an article entitled "High School Dropouts: How much of a crisis?" reveals that the dropout rate has been decreasing every year since 1950 reaching an all time low in 1989 of 13%.

The Economic Policy Institute says that despite the fact that the United States spends less than any other industrialized nation (except Ireland and Australia) on primary and secondary schooling, the United States has enrolled twice the percentage of any other industrialized nation in higher education (except for Canada).

Are these statistics contradictory? What is the true state of Math Education in the United States? Are we in a bear market or should we be bullish? Other industrialized countries appears to think that we are doing something correct and that, in many cases, we are very successful. In fact Japan, Germany, Korea and the Scandinavian countries have come and stolen our materials. They have adapted them to their system and come back to challenge our students, with varying degrees of success, in international competitions.

Obviously, some of our students are not being educated to their fullest capacity in Mathematics. Philosophically, it has been maintained that to sustain a social order, we must do what is necessary. To do what is necessary, we must think that what has to be done is worth doing. To think it is worth doing, we must value it. To learn to value something, we must be taught a sense of values. It is apparent from the statistics that we have not convinced some of our students that school is valuable. It is obvious that some parts of our student body have not been converted. They are completely ignoring our efforts to save them. The logical question is who are they and why have we failed them. If the statistics are carefully examined, most of them are comparing different populations. It would appear that our college bound youngsters who are enrolled in Regents or College prep Mathematics instruction are doing extremely well. But the students who are career or job oriented are not only being discouraged but even worse disregarded. These are the students who are dropping out, failing simple math problems and being frequently absent or late to class.

If you want to find the reason for this, all we have to do is examine either the texts or curricula for the courses that these students are forced to take. These all stress pencil and paper exercises for the basic operations of Arithmetic. These courses try to make the exercises more meaningful by using real life activities that use rulers, recipes, wirings, elaborate colorations, non-sexist language, multicultural settings and other motivational devices that are considered "real world" experiences. For most of our students all of these endeavors are as meaningless as the pencil and paper they are forced to use to perform the tiring and endless examples which repeat the same "senseless" rules of Arithmetic. In actual fact, these students watch their elders using calculators, computers and formulae which eliminate the drudgery of Mathematics.

When I came to Smith High School in the South Bronx, I found countless examples of these students, The students' attendance and achievement in these courses were horrendous. Less than 60% were attending and the passing rate on the the RCT exams (eighth grade level Arithmetic) had reached an all time low of 37.1%. Obviously, a change was desperately needed. The course that I envisaged had to accomplish three purposes in the lives of our students. They must become computer literate, improve their consumer skills and be prepared to move into the work force with a skill that would break the cycle of poverty rampant in the South Bronx. As the course developed over two years, it met with resounding success. The attendance increased to over 90% on a daily basis (5% higher than the academic Math classes), achievement on the RCT exams reached 97.1% and the students were able to find part time jobs at Sears, Consolidated Edison and various banks using their knowledge of spreadsheets.

In education, there never seems to be any new courses that are unsuccessful but they always fade away when they their innovators leave. Upon investigation, it is apparent that, in their initial stage, the students and teachers are carefully selected to ensure success. At Smith this was not the case. All non-academic students must take the course as part of the regular curriculum. Over 500 students per term were exposed to the course. The three teachers who were forced to teach the course included two who were in danger of an unsatisfactory rating because of lack of attendance or incompetency in technique. The third was very limited in his communication skill because of a severe language deficiency. They were all reluctant to try "another new course". However, as the students' enthusiasm engulfed their classes, the teachers went from "burnt out" to "turned on" models in the classroom. In the course, our students were introduced to various spreadsheet commands to end the tedium of Arithmetic. They were allowed to pick their own real life situations such as baseball statistics or financing the purchase of a car and a house. In contrast to other courses, the teachers and students literally had to be thrown out of the computer room at the end of each class.

In conclusion, where is Mathematics education today? It is doing a good job on the the majority of our students under the American system of education. We are both envied and imitated in most industrialized nations. The situation is definitely bullish. But the world is watching us to see how we handle the one aspect that is still bearish, the non-academic student. The movement is to make these students take more academic courses. Obviously, this has not worked in the past and will not work in the future. It is time for us, as leaders of Mathematics education to realize what we need for our non-academic students. A course such as the one I introduced has accomplished a bull market for these students. It may not work in every situation but it is a start in the right direction. It has turned Math education in Smith High School into a complete bull market.

ISSUES IN NUCLEAR ENERGY

AN STS UNIT FOR HIGH SCHOOL CHEMISTRY

Kevin Koepnick
City High School
Iowa City, Iowa 52245
(319) 339-6811

City High's Basic Chemistry course serves two primary purposes. First, many students desire a college-prep chemistry course, but do not plan on pursuing a science major in college. Basic Chem will be the last science course many of these students take. This reality leads to the second goal: to provide students with an opportunity to explore the interactions of issues in science, technology, and society.

While providing students with a general background in introductory chemistry, Basic Chem deals with societal issues in three general areas of chemistry. The first trimester looks at issues in environmental chemistry. During the second tri, nuclear energy is examined. Third trimester students are faced with problems in consumer chemistry. All three issues units include lab experiences, readings of current articles from the popular press and science journals, and videos discussing problems and potential solutions. Each trimester, students prepare a position paper on an issue of personal interest within the general topic area.

The unit on nuclear energy has always been of great interest. This year, the unit started on January 13, three days before the beginning of Operation Desert Storm. Needless, to say, the kids were engaged. The general unit plan might loosely be termed a sort of learning cycle. First, an effort is made to engage the students with an exploration of the history of the arms race. Next, concepts are developed through lab experiences, lectures, and readings on atomic structure and the release of nuclear energy. Finally, these concepts are developed through lab experiences, lectures, and readings on atomic structure and the release of nuclear energy. Finally, these concepts are applied as students operate a computer simulated nuclear power plant and examine different methods of disposing of high-level waste.

The unit begins with questions posed to the group. First, "What do you know about nuclear energy?" All answers are accepted without discussion and recorded on the board. Responses typically include:

- "It comes from atoms."
- "It's dangerous."
- "It was wrong to bomb Hiroshima."
- "$E=mc^2$ . . . whatever that means."
- "You can make electricity with it."
- "The waste is dangerous."
- "It makes really big bombs.

Next, we ask, "What do you think you ought to know?"
- "What atoms are?"
- "How bombs are made?"
- "Who has the bomb?"
- "How and when nuclear weapons are used?"
- "Where nuclear power plants are located?"
- "Where nuclear waste is stored?"

Finally, we ask, "What do you want to know about nuclear energy?"
- "Is our electricity nuclear?"
- "Are there any nuke plants around here?"
- "What happens to the waste?"
- "Are there any bombs around here?"
- "Is Iowa City a target?"
- "Why did we bomb Japan?"

The history of the nuclear age is introduced by having the students read an article from Science 84 on the people involved in the Manhattan Project (Lightman, 1984). We then view the award-winning film "The Day after Trinity". To bring students up to date, NOVA's program "Nuclear Strategy for Beginners" takes beginning strategists through the events of the Cold War up to the time of Star Wars and deterrence. Three main activities bring up some of the realities of nuclear war. "Drop the Bomb" asks students to target a number of cities for destruction, using 50 Minuteman III missiles, each with three warheads. Since the students know little abut Soviet cities, we target American cities. "Current Nuclear Armaments" has students refer to such sources as The Nuclear Weapons Data Book (Cochran, 1984) to prepare capsule summaries of such weapons systems as the Poseidon sub, Minuteman III, and Air Launched Cruise Missile. Finally, the nuclear winter hypothesis (Sagan, 1983) is introduced and explored as a possible deterrent which all countries must respect.

Once students are concerned with the possibilities of nuclear energy, it's time they learned about the nature of the atom and the ways in which energy is released. The second phase of the unit has students doing labs and readings about atomic structure. Lab activities include a shielding experiment in which students use radioactive sources and Geiger counters to determine which forms of radiation can pass through which substances, making inferences about particle size and speed, Rutherford's experiment is simulated using a computer (Rittenhouse, 1988), and again by rolling marbles at a fixed target. The old "Black Box" experiment is performed, asking students to infer the contents of a sealed box by manipulating it from the outside. All of these labs are intended to demonstrate the idea that atomic structure is inferred from evidence, rather than observed directly. Finally, some of the applications of special relativity are brought up, notably the energy-matter relationship $E=mc^2$.

The third phase of the unit applies the energy-producing aspect of nuclear energy as students explore the risks and benefits of nuclear power. After reading and hearing about the design of nuclear power reactors, students are given the chance to operate their own station via computer simulation. Of the simulations available, I've found one to be most useful due to its simplicity and very low (free) cost (Berggren 1980). Students evaluate their own performance and then read and discuss the problems of high-level waste disposal. The video used with this part of the unit is the NOVA program "Back to Chernobyl".

Students are asked to explore their own opinions on some issue in nuclear energy as they prepare the second trimester position paper. Any nuclear-related issue is fine. In the paper, students are expected to define the issue, discuss opposing points of view, explain the science needed to make a responsible decision, and explain their own position. The position paper takes the place of the exam for this unit.

While all of this is going on, the annual Basic Chem Nuclear Film Festival also takes place. Many wonderful movies have been made about issues of the nuclear age. Students who come in after school to watch some of these films are awarded extra credit. This year, a dozen movies were scheduled during the months of January and February.

Decision-makers need facts. Like it or not, high-school juniors and seniors become voters in just a short time. It's difficult to imagine which STS issues are more vitally important than those which involve the energy locked within nuclei. This unit is our attempt to inform the decision-makers of the immediate future.

References

Berggren, S.R. (1980). Apple Nuclear Power Plant. Creative Computing December, pp. 130-137.

Cochran, Arkin and Hoenig. (1984). The Nuclear Weapons Data Book. Cambridge, MA.: Ballinger Publishing Company.

Department of Energy. (1990). Annual Report to Congress. Office of Civilian Radioactive Waste Management.

Department of Energy. (1987). Progress Report on the Scientific Investigation Program for the Nevada Yucca Mountain Side. Office of Civilian Radioactive Waste Management.

Department of Energy. (1987). Atoms to Electricity. USDOE Assistant Secretary for Nuclear Energy. Office of Support Programs. Wasington, DC 20585.

League of Women Voters. (1985). The Nuclear Waste Primer.New York: Nick Lyons Books.

Lightman, A.P. (1984). To Cleave an Atom. Science 84. (5): 9. pp. 103-108.

Mayers, T.K. (1986). Understanding Nuclear Weapons and Arms Control. Washington: Pergamor Brassey's Internatonal Defense Publishers.

Rittenhouse, R.C. (1988). "Alpha-Scatter". JCE: Software. Division of Chemical Education of the American Chemical Society. Vol. IA: I.

Sagan, C. (1983). The Nuclear Winter. Parade Magazine. October 30. (pp. 4-7).

FILMS

Amazing Grace and Chuck
Back to Chernobyl (NOVA)
China Syndrome
The Day After
Dr. Strangelove . . .
The Hunt for Red October
Nuclear Strategy for Beginners (NOVA)
Search for the Super
Testament
Wargames

Atom, The (Mechanical Universe)
Butter Battle Book
Dark Circle
Day One
From Atoms to Quarks (Mech.Univ.)
Nightbreaker
On the Eighth Day
Silkwood
War and Peace in the Nuclear Age (PBS Series)

Name __________________
Section __________________

BASIC CHEMISTRY
ISSUES IN NUCLEAR ENERGY
TO CLEAVE AN ATOM

Use the accompanying article to answer each of the following questions.

I. How was the atom pictured prior to the discovery of the electron? How did the discovery of the electron call the old ideas into question?

2. Describe Rutherford's experiment. Explain the evidence for his conclusions.

3. Describe Bohr's "drop of liquid" analogy for the process of nuclear fission.

4. Why is nuclear energy so much more potent than any form of energy known before?

5. What do you think the author means when he speaks of "abstracting" the danger of nuclear arms away?

Nuclear Education Name: ______________

Activity I: Drop the Bomb!

You are in command of fifty (50) Minuteman III missiles, each equipped with 3-W78 nuclear reentry vehicles with a total kiloton yield of 1005 kilotons (or about 1 megaton). Your total available yield is roughly 50 megatons.

Your objective is to maximize civilian casualties by targetting your missiles to destroy as much of these cities as possible. We will assume the destructive area of a 1 megaton explosion is 80 km^2. Target your missiles, but do not fill-in the "Deaths" column. When you are done, your teacher will help you complete the activity.

City	People/km^2	Area in $km/^2$	missiles targeted	# deaths
New York	10,000	780		
San Francisco	6,040	117		
Philadelphia	5,810	335		
Chicago	5,810	572		
Boston	5,380	120		
Washington, D.C.	4,730	159		
Newark	6,270	60		
Baltimore	4,460	203		
Detroit	4,230	360		
St. Louis	3,920	160		
Cleveland	3,810	198		
Pittsburgh	3,620	143		
Milwaukee	2,920	247		
Minneapolis	3,040	143		
Long Beach	2,850	127		
Seattle	2,460	216		
Los Angeles	2,350	1203		
			TOTAL	

From Jan Wielert, Iowa City West High School

Nuclear Education Name: ________________

Activity 2: Current Nuclear Armaments

Materials: Fact Sheets

- W80 warhead
- W78 warhead
- W68 warhead
- Minuteman III Missile
- Poseidon C3 Missile
- AGM 86B Air Launched Cruise Missile
- Poseidon Submarine

In the space below this description and questions, make a summary of the Poseidon submarine missile system. Use the questions as a guide. Your teacher will work through this phase of the activity with you.

Question: How many missiles does a Poseidon submarine hold?
How many warheads can each C3 missile hold?
How many Poseidon subs contain C3 missiles?
What missiles do the remaining Poseidon subs contain?
How many Poseidon subs are on active duty at any time?
What is the maximum number of warheads a Poseidon submarine can deliver (assume C3 missiles)?
What warheads are used on the C3 missile?
What is the kiloton yield of each warhead?
What is the total yield for one Poseidon sub with C3 missiles?
Where do Poseidon subs patrol?
What is the range and speed of the C3 missile (assume 10 RV's per missile)?
What types of targets are C3 missiles aimed for?

Poseidon submarine system . . . . . .

From: Jan Wielert, Iowa City West High School

On your own, make similiar outlines of the following weapons systems . . .

Minuteman III system . . .

AGM 86B Air Launched Cruise Missile System . . . . .

Name ______________________
Period ______________________

BASIC CHEMISTRY
ISSUES IN NUCLEAR CHEMISTRY
THE NUCLEAR WINTER HYPOTHESIS

Use the space provided to respond to the following questions regarding Carl Sagan's article "The Nuclear Winter".

I. According to the World Health Organization, how many people might be expected to suffer death or serious injury as a dirct result of a nuclear exchange?

2. Scientists are generally very conservative when making predictions of future events. Why might this practice not be the best approach when predicting the after-effects of a nuclear war?

3. Explain the origin of the nuclear winter hypothesis.

4. What would be some of the effects of a "nuclear winter" on living things?

5. What effect does the size of a nuclear exchange have on climatic effects?

6. Many politicians advocating further arms build-up are labelled as "conservatives", while those in favor of arms reduction are called "liberal". In this case, how do the labels fit the facts?

Name ______________________
Period ______________________
Date ______________________

Basic Chemistry
Nuclear Film Festival - 1991
Film Summary

Use the space provided to respond to the following questions about today's film.

1. Film name ____

2. In very few words, do your best to summarize the plot of the film.

3. List the main characters and give a short description of each.

4. What issues does the film raise?

5. What is the film-maker's point of view?

6. What do you conclude about the issues raised by the film?

LAWN CLIPPINGS:

A

STS ISSUE

By

Lloyd H. Barrow, Ph. D.
Professor of Science Education
Southwestern Bell Science Education Center
104 Townsend
Missouri University
Columbia, MO 65211
(314) 882-7457

Funding was provided by the Missouri Board for Higher Education for the program described in the paper.

LAWN CLIPPINGS: A STS ISSUE

During the summer, 1990, a total of 21 grades 4-9 teachers participated in a seven day in-service program. The teachers were selected to become part of a cadre of science teachers to incorporate STS into their local curriculum. Each teacher was recommended by their building administrator as a leader. The teachers were to conduct a local in-service on STS, design and field test a STS unit, and participate in a follow-up meeting during November, 1990.

Since the teachers were representing the entire state of Missouri, the project staff had to decide on a broad issue that would relate to all geographic regions of the state. The starting point was the amount of space available in sanitary landfills. Rather than being told what is STS: it was decided that the teachers should experience STS. So it was determined that lawn clippings and their disposal would be utilized to model how to teach from a STS orientation.

On the first day of the summer workshop, project staff ascertained how many of the participants dropped their lawn clippings, collected the clippings and sent them to the landfill or composted them. The initial reaction of rural teachers was that everybody would either drop the clippings or add to the compost pile. Data that approximately 30% of state residents bag their lawn clippings and this constitutes 21% of daily landfill collections was shared. Of the 21 participants, seven bagged their lawn clippings. We were unable to determine the quantity because two individuals employed commercial companies to take care of their lawns. They were uncertain where the clippings were taken. How could they determine what occurs to lawn clippings in their local areas?

It was decided that over the weekend, each participant would survey their community. A committee devised a strategy to collect data. Their procedures involved a telephone survey of 26 homes/participants. Each participant called the third non-commercial listing for each letter of the alphabet from their local telephone directory. After repeated trials, with no response, they were to contact the next non-commercial listing. For each home that bagged their clippings, they were to identify the average number of bags per week. Three other committees were to research and present information about how clippings decompose in a compost pile, landfill, and when dropped on the ground. Each teacher was assigned to one of the three committees.

At the start of the second week of the workshop, the three committees shared their research on how clippings decompose. The class as a whole tabulated the results of their lawn clippings and telephone surveys. Approximately 23% of the telephone respondents sent on an average of 2-3 bags per week to the sanitary landfill. The average was fairly consistent regardless of urban, suburban, or rural locations/locales. Even rural residents were surprised about the data for their community. A logical question that then arose was whether bags were a standard size or not. After further discussion it was concluded that the survey should have collected more information about the bag size and how full were the bags. This was discovered when one telephone respondent indicated that they could only carry the bags half-filled.

At the follow-up session, some of the teachers had utilized the lawn clippings format in their classes. Their students were more thorough in their design of the survey than they had been. Local issues should be utilized in preparing teachers to teach from a STS orientation. Let them experience the excitement of learning.

ELECTRONIC PRINCIPLES AND APPLICATIONS
USING A HANDS-ON, S-T-S, CONCEPT-BASED CURRICULUM DESIGN

Michael Jaeger
Eastern Oregon State College
1410 L Avenue, La Grande, Oregon 97850-2899
1-800-452-8639, Ext. 23529

It seems that most curricula that deal with electronics[1] tend to be of one of three dimensions: 1) one that treats the topic as a portion of physics with the phenomena, theoretical and algorithmic explanations and the associated computational examples (e.g., Marion, 1981; Taffel, Baumel and Landdecker, 1981; Haber-Schaim, Dodge and Walter, 1986); 2) one that treats electronics as a vocational art, using the components as building blocks to useable products, where skills and technology are emphasized (e.g., Buban and Schmitt, 1892; Schuler, 1979; Fowler, 1979; and Fuller and Miller, 1979); or 3) one that considers electronics as a descriptive field of science without benefit of any laboratory or computational examples (eg. Appenbrink et. al., 1981; Eby and Horton, 1988; Miller,1976). These three paradigms create physics classes where students perform generalized experiments from which they compute theoretical problems of circuitry with little idea about practical application, or vocational classes where students build amplifiers and oscillators with little comprehension of theory, or general science classes where passive students learn vocabulary and recite applications with little manipulative or discovery experiences.

A further observation of these three views of electronics education involves teaching materials. Physics-electronics classes usually require special laboratory equipment such as analog or digital Volt-ohm meters, wheatstone bridges, oscilloscopes and the other trappings of the "laboratory." (Haber-Schaim, et. al., 1986) These materials are expensive and often unreliably calibrated. Student results from experimentation tend to be spurious. When there are enough power sources, meters, oscilloscopes, and connectors, and they do operate correctly, students have difficulty in learning appropriate circuit connections of the meters, operational and safety procedures and interpretation of the myriad of numbers and scales that most equipment offers. For example, a demonstration showing Ohm's law typically requires analog meters, variable linear resistors, a DC source, an ammeter, and a voltmeter (Kutliroff, 1975). This experiment often becomes an exercise in whether students can control all the variables, connect appropriate wires and gather pertinent data. Much time is spent in learning how to connect ammeter and voltmeter, and how to read the various scales and multipliers. Further, once data is gathered, little transfer is made about where application is made about this phenomena. Even though our world is permeated with electronic applications, little formal effort is given to a Science-Technology-Society approach. Physics-electronics classes leave students with a head full of formulae and problems, but without examples of application.

Vocational-electronics classrooms study much of the same electronics content as a physics-electronics class, the aim of most of this middle and high school work, however, is product-oriented. The concepts, principles and machines used are as a means in making or producing a product or applicable circuit. Students construct power supplies, oscillators, amplifiers and "gimmick" circuits as an outcome of their learning. A source of great motivation to learn Ohm's law is the right to build a consumer device. As a result, projects or kits consume a student's time and do not necessarily contribute to his or her electronics conceptual framework. Although the products are tangible gadgets that solve or create the "S" or "T" in STS, there is little science that links the three. Vocational-electronics education leaves students with a locker full of gadgets and few concepts about how they work.

Descriptive treatments of electronics are equally suspect. Texts often treat electrical phenomena with the sweep of a few paragraphs and pictures. Students are reduced to reading passages or watching films, then reciting vocabulary definitions of electronic terms with little or no hands-on experiences. Laboratories, when present, are typically designed to accommodate the simplest of materials, yielding yet more complex and more uninteresting portions of electronic science. Series and parallel circuit experiments using light bulbs or resistors abound in this sort of curriculum. (Prentice-Hall, 1991; Silver Burdett and Ginn, 1989) Although students can assemble these demonstrations, the conceptual underpinnings such as voltage division, current flow and the concept of resistance is secondary, if not altogether absent.

A New Curriculum Paradigm

Somehow students need to experience electrical phenomena first-hand. They need to realize the amazing physics behind the scenes of the phenomena, and they need to know how the theory is applied to discrete technological devices. Somehow, the physics, vocational, and general science classroom needs to be melded into a new paradigm of electronics education. How can students learn the big ideas without the mess of wires, meters and formulae; how can they learn real world applications without soldering a kit together; and how can they learn the "stuff" of science within a meaningful context?

There have been some efforts to bring more electrical science to the classroom mandated by the aforementioned goal statements. The Intermediate Science Curriculum Study (Florida State University, 1970) developed several hands-on lessons that involved data gathering, conceptualization and applications. Students assemble a meter device, make an arbitrary scale for measuring and infer relationships between voltage, current and resistance. Unfortunately, the materials require substantial set-up and are relatively complex. Although the curriculum does a good job of helping students understand electricity and energy, little is done to elaborate upon specific applications and technology.

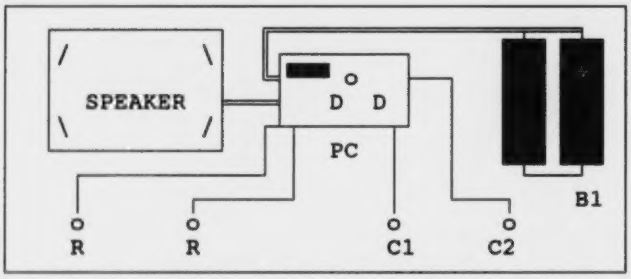
The purpose of this paper was to join these three viewpoints into one unified curriculum. The experiments and activities offered by the project presented here[2] require that the student not only discover some principles of physics, but also apply those principles to real world technological solutions. Students learn the concept of capacitance and apply the concept to make a pressure sensitive scale. They explore the concept of resistance and make their own volume control and synthesizer. Finally, they explore the concept of electrochemical cells and make their own batteries.

The core of this melded curriculum depends upon a recurrent theme of instruction: What concept can be gleaned from experimentation, and what good is it? The curriculum uses guided discovery as a methodology for developing both conceptual and applied themes and depends almost solely on hands-on activities incorporated within a special inexpensive module called the "Beeper."

The "Beeper" allows students to discover very important concepts with very simple connections. Data is recovered by audible clicks produced by the "Beeper" oscillator. Students typically engage in open-ended invention, follow general directions about setting-up experiments, and generate ideas about their discoveries. The materials are reasonable, require little former background in science or technology, yet, ask students to make important inferences about principles and mechanisms found in electrical science.

The module itself, although very primitive in design, provides students with a tool for exploring electronic principles. (See Figure 1.) The "Beeper" circuit is a simple two-stage direct-coupled complementary amplifier (Garner, 1956 and Brown, 1968) with input and output coupled to form a frequency multivibrator. The Frequency can be controlled by changing the resistance (R), capacitance (C1 and C2), and battery variables. (See Figure 2.) The resultant output is a tone emitted from the speaker varying from a rate of .05 to 20,000 hz. At the lower end of the spectrum, students can use the Beeper as an audibly

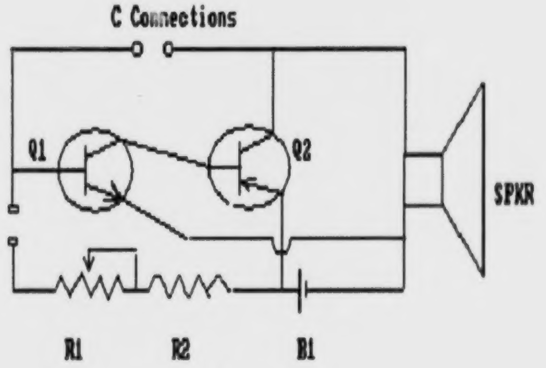
Figure 1
Beeper Module



Square marked "PC" is a printed circuit board with Q1, Q2, R1 and R2 calibratable meter. At the upper range of the spectrum, students can use tones as qualitative measures of the variables at their control.

The design of the "Beeper" is such that high resistance values such as skin, aqueous solutions, and semiconductor materials create significant shifts in time constant. Students holding the R connectors will cause a click rate of approximately 60 per minute with a 2 microfarad capacitance. Data can be easily gathered by listening to clicks per unit time and can be compared to new variables applied to the system.

Figure 2
Beeper Schematic



When the R connectors are fixed with a 1 megohm resistance, C1 and C2 capacitance variables become sensitive to an array of plates and dielectrics. Click data can be gathered for simple foil and wax paper capacitances assembled by the student.

Concept Curriculum

The experiments in this curriculum have been designed so that students need only follow simple pictorial circuit diagrams. Connectors and posts are different in a tactile sense so that this experimentation can be done by non-sighted individuals. Circuit pictorials and descriptions are provided for each set of connections and an effort has been made to "de-mystify" the connectors and components by using common items: a wooden base, nails for binding posts, paper clip connectors, and an open circuit board. Although the experiments are easy to construct and make work, students are asked to progressively work from the tangible to the symbolic to the abstract by learning the particular taxonomy and classification of electronic components such as codes and values of resistors, markings and parameters of capacitors, and characteristics of photocells, thermistors and other devices.

Each lesson first directs students to experiment with a particular variable, record observations, and then develop a generalization about the phenomena. Students may "discover" something that is incorrect in this process. The instructor must be aware that in designing instruction under this learning configuration, effort must be taken to collect observations and discoveries from all student groups so that the class can agree on what data seems spurious. This curriculum encourages discovery and de-emphasizes telling a student what should have been observed. It does require an instructor to guide the discovery process with specific direction. For example, in one experiment students hold hands and add a new student to the chain to observe the rate of click. Students report the rate of click and should observe a slower frequency. The instructor must collect such data and have the class summarize the effect incorporating contributing data and seeking explanation for the spurious data. Although interesting variables can be serendipitously discovered along the way, the objective of the activity remains clear: series resistances have a summative effect on electronic circuits.

Process Skills

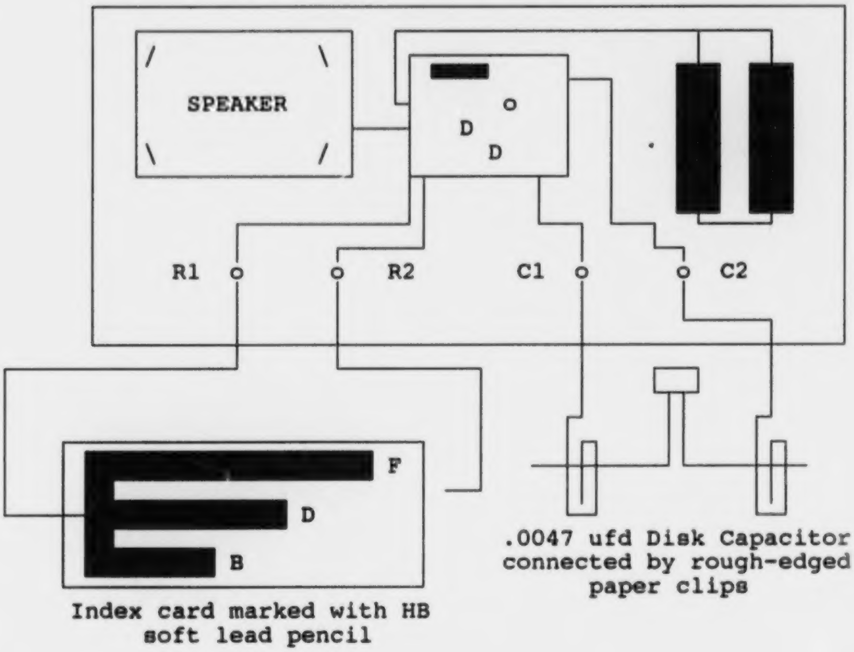
Data gathering, graphing and interpretation are important skill areas emphasized by each of the lessons. Since the data that is gathered is arbitrary: clicks, grains, centimeters of carbon ruling, tone, loudness, etc., students are more comfortable in making observations and in manipulating variables. Inferences are easier to make when the technical trappings are simplified.

STS Linkages

Attached to each lesson is a Science, Technology and Society application. Here students are encouraged to use the newly explored phenomena to develop a useable product suitable for their own homes. In one activity, for example, students use pencils to create resistances of varying lengths. Although the content of the lesson describes the relative values of resistance as a function of density and length of the carbon and clay substrate, the STS extension of the lesson has students create an index card synthesizer from different resistance values of penciled rows. (See Figure 3.) Each lesson points students to the linkage their inventiveness has with technological realities.

In another lesson module students calibrate the beep rate for a sample of distilled water. (See Figure 4.) As grains of salt are added and mixed into solution, the beep rate increases and can be graphed as a smooth curve. The curve then allows students to collect beep rates for other sources of water and then interpolate the amount of dissolved salt in solution. Inferences about water purity and pollution can be drawn that allow students to generalize about health and environmental questions based upon the data they record. Students do not focus on the interpretation of scales or meter reading, but can generalize from unitized data unique to each "Beeper."

Figure 3
STS Extension for Making a Audio Synthesizer



.0047 ufd Disk Capacitor connected by rough-edged paper clips

Index card marked with HB soft lead pencil

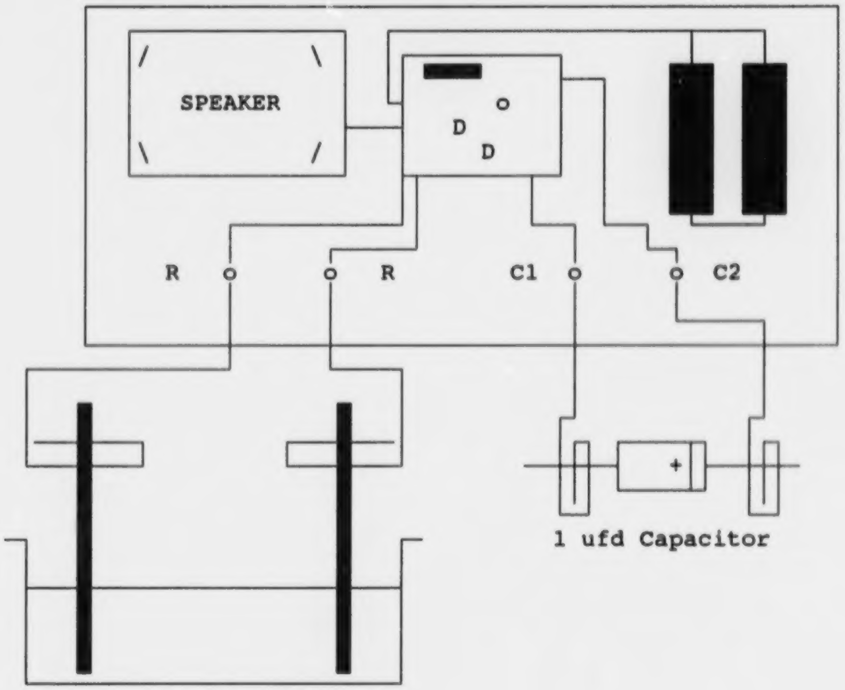
Initial Results from Field Testing and Summary

Almost 100 upper elementary, middle school and secondary science teachers have been introduced to this curriculum design through inservice training. Most of the teachers asked to evaluate the curriculum had little or no experience in electronics prior to the inservice. Attitudinal data was collected which asked teachers to respond whether they thought the materials would be of value in the classroom. Ninety per cent of the respondents enthusiastically responded to the potential for classroom application and of that group, two thirds applied as field test sites for initial implementation of the materials.

On-site testing is underway in several urban and rural settings. Feedback from these initial sites will help mold the curriculum to fit the readability, developmental characteristics, and interests of students. Additionally, pragmatic information about durability, technological glitches, or difficult procedures will be discovered. Honing of the device and curriculum and wider pilot testing of the materials is planned.

Evaluation of materials and curriculum will focus on two basic points: 1) Were students able to construct and design experiments that helped them infer generalizable concepts? And, 2) were students encouraged to explore and invent applications of the

Figure 4
Beeper Module Set-up For Water Testing



Carbon rods attached to
Resistance leads of Beeper

technology to real-world problems? Student and teacher evaluation instruments are planned which will collect both objective and subjective feedback.

Information from this testing may yield an important new piece of curriculum design that solves the problems presented by traditional treatments of electronic science. Electricity and electronics permeates our daily lives with a myriad of applications. It seems appropriate that the science classroom pay particular attention to the good science that can be learned from teaching the concepts and applications of electronics.

Footnotes

[1] For the purposes of the discussion of this paper, electronics shall be defined as theories, practices and applications of electrical devices and circuits. Such topics include energy, resistance, capacitance, inductance, circuitry; devices such as resistors, capacitors, coils, thermistors, photocells, and semiconductors; and applications such as control circuits, power circuits, oscillators, metered circuits and amplifiers.

[2] The curriculum project noted here is the substance of the project entitled: "Electronic Principles and Applications Using The Beeper Board: A Science, Technology and Society Curriculum Proposal for Grades Seven through Twelve." This project, written by the author, was initially sponsored by a Dwight D. Eisenhower Title II Curriculum Research Grant aimed at identifying and teaching goal-orianted science. Further funding was underwritten by Eastern Oregon State College Faculty Research Grants and the School of Education.

References

Appenbrink, D. et. al. (1981). Physical Science. Englewood Cliffs, NJ: Prentice-Hall, Inc. 295-315.

Brown, B. (1968). 104 Easy Transistor Projects You Can Build. Blue Ridge Summit, PA: Tab Books. 89-90.

Buban, P. & Schmitt, M. (1982). Understanding Electricity and Electronics. New York, NY: McGraw-Hill Book Company.

Buban, P. & Schmitt, M. (1977). Technical Electricity and Electronics. New York, NY: McGraw-Hill Book Co.

Eby, D. & Horton, R. (1988). Physical Science. New York, NY: Macmillian Publishing Co. 341-45.

Florida State University. (1970) Probing the Natural World 1. Morristown, NJ: Silver Burdett Company. 153-220.

Fowler, R. (1979). Electricity Principles and Applications. New York, NY: McGraw-Hill Book Co.

Fuller, N. & Miller, R. (1979). Experiments for Electricity and Electronics. Indianapolis, IN: Bobbs-Merrill Educational Publishing.

Garner, L. (1957). Transistor Circuit Handbook. Chicago, IL: Coyne Electrical School. 228-31.

Haber-Schaim, U., Dodge, J., & Walter, J. (1986). Laboratory Guide to PSSC Physics. Lexington, MA: D.C. Heath & Co. 56-7.

Heath Company. (1981). Concepts of Electronics. Benton Harbor, MI: Heath Company.

Kutliroff, D. (1975). 101 Classroom Demonstrations and Experiments for Teaching Physics. West Nyack, NY: Parker Publishing Co., Inc.

Marion, J. (1981). Physics in the Modern World. New York, NY: Academic Press.

Miller, R. (1976). Electricity and Electronics. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Miller, F., Dillon, T., & Smith, M. (1974). Concepts in Physics. New York, NY: Harcourt Brace Jovanovich, Inc. 321-39.

Prentice Hall. (1991) Physical Science Laboratory Manual. Englewood Cliffs, NJ: Prentice-Hall Inc.

Schuler, C. (1979). Electronics Principles and Applications. New York, NY: McGraw-Hill Book Co.

Silver Burdett & Ginn. (1989). General Science Laboratory Manual. Morristown, NJ: Silver Burdett & Ginn Co.

Taffel, A. (1986). Physics: Its Methods and Meanings. Newton, MA: Allyn and Bacon, Inc.

STS, WOMEN'S STUDIES, AND THE TRANSFORMATION OF THE UNDERGRADUATE CURRICULUM

Barbara Beigun Kaplan, Ph.D.
Acting Executive Director, STS Program
University of Maryland College Park
College Park, MD 20742
(301) 405-5259 (w)
(301) 977-4459 (h)

There has been considerable rhetoric in recent years regarding the need to reform the undergraduate curriculum so that it will reflect current realities of our technological society--realities which involve rapid information gathering and dissemination, extensive intercultural contact, and the interrelatedness of politics, economics, and social and technological development.

Our traditional ways of systematizing knowledge have appeared to us for a while now to present problems of narrowing perspective and isolating variables to the detriment of contextual considerations. The language specialists employ to clarify and delineate concepts within their own fields--and indeed to carve out these fields as legitimate disciplines in the first place--have created jargon barriers which hinder communication between disciplines at precisely a time when integration of information is becoming more and more necessary.

We are faced with the intellectual and psychological dissatisfaction of living in a world where the assimilation of great quantities of information gives rise to increasing specialization and theory development within narrowed parameters while assessment of the appropriate use of the resultant knowledge within human society requires a broad, holistic perspective and multifacted analysis of which we are less and less capable. The resulting frustration has prompted, in the last half of the twentieth century, educational reform movements calling for "relevance" in education and a reappraisal of our traditional tests of objective "truth." The 1960s, as is well known, was a time of particularly heightened awareness of the need for educational institutions to become more socially responsible. This effort was spurred by social reform movements outside of academia, such as civil rights, environmental accountability, and the anti-war movement.

It was during this period that both women's studies and STS gained a foothold on college campuses. The social protest movements (of women's liberation in the first case and concern over misuse of technology in the second) spawned the initial interest in these subjects and thus provided justification for their study within colleges and universities. The ideological origins and the continuing ideological component of both STS and women's studies not only provide an identifiable focus for research within each field, but also link the two fields by their shared commitment to social change. They create opportunities for collaboration that can be significant in promoting reform of general undergraduate education, particularly in the redesign of core requirements.

The purpose of this paper is to review the conceptual foundations of the two fields, to articulate the similarities between them, and to explore the ramifications of collaboration between women's studies and STS studies researchers both for enhancement of their own disciplines and for the promotion of broader curricular reform.

The relevance of the women's liberation movement to women's studies is commonly noted by feminist writers. Helen Weinreich-Haste (1986:119), drawing upon the historical record of feminism, points out that "feminism, at various points in history when it has emerged as a dominant force in social thought, has never been confined solely to the demand for legal changes; it has always been associated with efforts to change the conception of sex roles and sex differences." This latter effort has prompted a considerable degree of scholarly research, including (and this is of particular interest to us) a feminist critique of science. In Feminist Scholarship: Kindling in the Groves of Academe, the authors note how the "connection to the women's liberation movement has provided a foundation for shared perspectives and ideas" while the "analytic concepts of oppression and liberation have been especially important as organizing principles for the feminist scholar" (DuBois et al., 1985:199). They go on to say that while there are many varieties of feminist scholarship, what gives coherence to the field is its link to the more general feminist movement.

The authors make a careful distinction between the ideological focus which unites women's studies research and the shared–subject–matter focus which provides coherence to other interdisciplinary fields, such as American or urban studies. "It is not just the subject of women that unifies feminist scholarship," they explain. "Rather the politics of modern feminism provides women's studies with an additional way to bring together diverse scholarship into a unified endeavor" (DuBois et al., 1985:199).

STS, as a subject of study, shares this unique situation of having its origins in a social movement arising outside of academia. George Bugliarello (1986), speaking of the conceptual foundations of STS, notes how one can view STS as both an ideology and a discipline. "As an ideology," he writes, "its aim is to shape the relationship between technology and the rest of society according to certain beliefs as to the nature and purpose of technology." As a discipline, the objectives are to "understand the interactions between a technological system and the social environment both inside and outside of the system" and to "shape the interactions among social systems to respond to specific goals." Indeed, the very commitment of the national association of STS (NASTS) to maintain strong ties with those directly involved in reform efforts, such as environmentalism, and to represent itself as an umbrella organization in which a wide variety of voices can confer together to further the cause of scientific and technological literacy, indicates that this link to its social reform origins is still very much alive.

Just as women's studies researchers attempt to uncover the cultural biases which are responsible for unequal treatment of women with the hope of fostering social change, so STS has a mission to fulfill in identifying the operative values which determine the course of technological activity (Goldman, 1986), thus promoting better understanding and the hope of eliciting more intelligent policy decisions. As Langdon Winner puts it, the STS field of inquiry "occupies an enormous void, one created by a society that long ago committed itself to forge ahead full bore with scientific and technological advance, but never to forge ahead in developing the critical self-reflection such change seems to require" (Winner, 1986). Discussing current trends in STS scholarship, Stephen Cutcliffe (1989:23) maintains "...we are now beginning to move into a phase where STS may help to shape public response and involvement in decision making regarding scientific and technological change both by providing an awareness of the public's intimate involvement and by offering suggestions regarding the specific role that it has to play."

Both women's studies and STS studies have gone through several developmental stages (some quite parallel) to reach their present level of intellectual sophistication. *Chart 1* highlights the stages and the parallels. Initially *[Stage 1]*, the emphasis in the feminist movement was to identify the historical contributions of women as a corrective to the notion that women's activities were of limited significance and therefore unworthy of study. The next stage *[Stage 2]*, which occurred when formal women's studies programs were first organized in higher education, was to investigate women as a disadvantaged group, to determine the social forces which led to devaluing women's roles and viewing females as subordinate. As women's studies developed *[Stage 3]*, researchers turned inward to analyze differences among groups of women (with special attention to racial and class diversities) in order to articulate more fully the variety of female experience. Currently *[Stage 4]*, much work in women's studies involves using gender as a category of analysis to challenge traditional paradigms in the various disciplines, and to cast doubt on the validity of such notions as historical periodization, behavioral norms, and the "objectivity" of the scientific method. The goals now are transformation and balance of the curriculum, rearticulation of paradigms, and integration of new knowledge.

STS studies within academia have gone through a similar metamorphosis. The earliest work first addressed the idea that science and technology were social enterprises. The anti–technological, anti–establishment focus of the 1960s prompted a renewed movement directed toward sensitizing scientists and engineers first to the social *[Stage 1]* and then ethical implications *[Stage 2]* of their professional output. It was at this time that STS programs and courses began to be established. (This parallels events in women's studies at this same time. Then, women's studies programs and courses were first being established and their focus, critical to the status quo, was to reveal how society at large had come to devalue women and to sensitize the scholarly community to the existence of biases and gaps in their own analyses.)

From this initial highly critical focus, STS studies then shifted *[Stage 3]* to an investigation of how a complex set of social values provide direction to scientific and technological research and influence how new discoveries and technological innovations are assimilated. As with women's studies, this inward-directed stage allowed for the exploration of cultural, class, racial, and gender diversities. In STS coursework, this broader social-context analysis was aimed at all students, not just those involved in science and engineering.

More recently *[Stage 4]*, STS has viewed its mission as one of conveying scientific and technological literacy to the general public, with the positive goal of creating a foundation for fuller integration of scientific and technological activity into the public consciousness--a foundation from which constructive dialogue and informed decisionmaking can emerge. The "integrative" stage also parallels current directions in women's studies toward curriculum transformation.

The history of women's studies and STS reveals commonalities, then, in their ideological origins and patterns of development. Both fields now have attained relative success in becoming formalized as academic programs or departments on university and college campuses and in gaining credibility for their scholarly research. Sufficient scholarship has now been generated for us to look at the potential for intellectual linkages between women's studies and STS. Since the fields are both fairly new and since their methodologies and perceptual paradigms continue to undergo significant development, one must avoid speaking of either field as having achieved consensus regarding a core theory. However, it is possible to isolate several areas of identity in focus and approach where collaboration can be useful *[Chart 2]*.

First, there is an essentially holistic outlook pervading both fields. A holistic viewpoint is, indeed, the raison d'etre of STS--recognizing the ramifications of science and technology in their broadest social context is intrinsic to the STS mission. A holistic point of view is similarly emphasized in women's studies research, where contextual elements are seen to be important considerations when addressing issues of gender roles and gender differences. Holistic thinking has also been considered a central characteristic of women's ways of knowing (Rosser, 1990; Keller, 1983). Sue Rosser has found, for example, not only that women investigate problems of "more holistic, global scope than the more reduced and limited scale problems traditionally considered (by men)," but "formulate hypotheses focusing on gender as a crucial part of the question being asked," use methods from a variety of fields or interdisciplinary approaches to problem-solving, and develop theories "that are relational, interdependent, and multicausal rather than hierarchical, reductionistic, and dualistic" (Rosser, 1990:44, 45, 50).

Collaboration is possible here between STS and women's studies scholars in the general articulation of the variety of parameters in which discussions of the role of women and of science in society can take place. The holistic approach serves as a useful corrective to thinking in too limited, deterministic terms.

Second, both women's studies and STS researchers share an interest in investigating the influence of values on human behavior and theories about the natural world. For example, work has been published in each field highlighting the misconception of science as value-neutral, and pointing out the variety of ways in which the articulation of scientific hypothesis, experimental design, and interpretation of results are value-laden, and therefore non-objective. Similar arguments have been made with regard to the development and dissemination of technologies.

In STS the notion of the scientific and technological enterprise as value-laden is a benchmark of the discipline. Much contemporary research has investigated group dynamics within the scientific community to reveal how new discoveries are, in effect, screened through a filter of paradigmatic expectations and validated or rejected on the basis of predetermined procedural conventions. Likewise, the dissemination of new technologies is often related more to external economic and political agendas (or simply to an expectation of "technological progress") than to any intrinsic utility of the technology itself. To explicate the science-technology-society relationships and interactions successfully involves developing an understanding of "what values are, how people come to hold them, and how values evolve" (Cutcliffe, 1989:25).

Several key works by feminist writers have investigated the ways in which values have historically influenced scientific and technological perceptions in specific areas and how these perceptions affect the social status of women. Carolyn Merchant's work, The Death of Nature (1980), traces the development of the notion of exploitation of nature in the mechanistic worldview of the seventeenth century, comparing it with the previous world order based on cooperation between humankind and nature, and relating it to the social sanctioning of the subordination of women. The work of Ruth Hubbard (1979) has revealed how closely the basic metaphors ("survival of the fittest," "competition," "ecological niche") and the assumptions of male dominance that Charles Darwin employed to articulate his theory of evolution and the associated theory of sexual selection reflect the Victorian social values of his day. Furthermore, these same value-laden and contingent theories of Darwin were later used to back up a variety of constructs of sociobiologists, resulting in descriptions of human sex roles and behaviors as innate and programmed into the genes (Hogsett and Rosser, 1983).

There is clearly opportunity for enhanced collaboration of STS researchers (particularly those competent in the history of science) and women's studies historians for the purpose of comparing findings on the role of values in the development of scientific and social explanations, investigating how individual scientific and technological innovations are perceived differently according to gender and race, and discussing the relevance of these findings to political and economic decisionmaking.

Third, opportunities for collaboration between STS and women's studies scholars exist because of their mutual concern for promoting social responsibility and their recognition that diversity of perspective should be respected. Much work in women's studies illustrates the strong concern for social responsibility present among women, linking this to the female nurturing role. More specialized research specifically on professional interests of men and women scientists reveals consistently that the women scientists are "unwilling to undertake research likely to have applications of direct benefit to the military and more likely to propose hypotheses to explore problems of social concern" (Rosser, 1990:41). Rosser cites, as an example, the opposition of Lise Meitner, the physicist who first described nuclear fission, to the use of her discovery to make the atom bomb. As a scientist, Meitner not only refused to become involved in the development of the bomb, but also directed her efforts toward promoting international cooperation to prevent use of atomic weapons (Rosser, 1990:42). Research has shown that women characteristically attempt to exert "positive control over the practical uses of scientific discoveries to place science in its social context" (Rosser, 1990:53).

Initial work by feminist researchers seeking to distinguish female perspectives from those of the male population failed to address fully issues of racial and economic diversity among the populations studied. But today a great deal of work focuses on the differences among women. Increased collaboration between women's studies and African-American studies highlights this commitment to address issues of diversity. (See for example, Margaret Andersen's essay, "Women's Studies/Black Studies: Learning from Our common Pasts, Forging a Common Future" in Schuster and Van Dyne, 1985.)

Interest in fostering social responsibility and recognition of diversity is central to STS studies too. From its inception, as we have seen, STS studies emphasized the importance of citizen participation and the promotion of responsible uses of science and technology. With growing sophistication, today's STS researchers attempt to identify and articulate the variety of cultural responses to science and technology with the aim of deriving more appropriate mechanisms of public involvement in scientific and technological decisionmaking.

Here is an area where the ideological missions of STS and women's studies intersect. If socially responsible use of science and technology is the goal, then STS researchers must address issues of diversity in perspective within as well as across population groups. Women's studies research into diversity among women can be particularly instructive here. As enhanced commitment to social responsibility can lead to corrective measures to combat gender inequalities, so this enhanced commitment can lead to appropriate public overseership of the scientific and technological enterprise.

Fourth, STS and women's studies can both benefit from ongoing attempts within each field to borrow methods and findings from traditional disciplines to structure and analyze their own research. Maintaining a broad interdisciplinary focus is difficult--in fact, it has been pointed out that due to this complexity, "recently feminist scholars have begun...to debate the virtues of integrating work from many disciplines versus conceiving of women's studies as a discipline in itself." And yet, "whatever shape the field of feminist scholarship eventually assumes, it will have been fed from many different disciplines" (DuBois, 1985:198). STS has been faced with a similar dilemma--how to gain acceptance within the academic community as a recognizable subject of study while maintaining its cross-disciplinary, inclusivist perspective. One way STS has looked for legitimation as a discipline is by attempting to articulate more clearly its conceptual foundations (Goldman, 1986) while calling for a synthesis of the methodologies and goals of the large number of existing disciplines having bearing on it (Bugliarello, 1986). By documenting the complexity of incorporating disparate methodologies while attempting to transcend the boundaries of traditional fields, STS and women's studies can educate each other as to how best to present themselves as viable disciplines in addition to perfecting their investigative procedures.

Fifth, the willingness of both STS and women's studies scholars to draw upon literature from an extremely wide range of sources and the success in opening up wholly new avenues of research have resulted in an increased potential for making novel correlations between events and for expanding the scope of both fields. An obvious example is the investigation of gender-specific technology, such as household technology and technologies of reproduction and child-rearing (Cowan, 1979, 1983 and Stanworth, 1987), which is of considerable use to those seeking to understand both the degree to which a given technology can affect society and how attitudes toward technology can differ between social groups within a single culture.

In her discussion of how women scientists' approach to investigation differs from the traditional (male-determined) norm, Sue Rosser notes that women expand their observations "beyond those traditionally carried out in scientific research to include various interactions, relationships, or events not seen or considered worthy of observation by traditional scientists operating from an androcentric perspective" (Rosser, 1990:38). She cites the example of Ellen Swallow Richards, a chemist who became head of the Woman's Laboratory at MIT, whose focus on food product purity and air and water contamination laid the basis for the field of home economics.

For STS and women's studies researchers, the study of activist groups and their impact on society and policymaking is of considerable value in drawing broader conclusions about how concerns about science, technology, and women can become catalysts for social change. Bringing to light the contributions of women in the history of science, using documents heretofore little consulted, such as women's diaries and personal correspondence, popular magazines, and records of women's organizations, already has proved useful in re-evaluating the historical record relating to both science and women. In general, the broadening of research opportunities engendered by both women's studies and the study of STS is highly desirable and beneficial to the growth of each field.

An increased association between those engaged in women's studies and STS has an additional benefit beyond that which each field can gain in intellectual acumen. The strengthening of linkages between STS and women's studies can have practical value for curricular reform, with regard both to restructuring the undergraduate core curriculum and to improving science, mathematics, and engineering education.

The current calls for general reform in undergraduate education are many, as is apparent from the number of reports on education generated by federally-funded agencies, private foundations, and educational institutions themselves. A primary target of reform efforts in higher education has been the reevaluation and restructuring of the undergraduate core curriculum. Approximately two-thirds of all the nation's colleges and universities either have recently reformed their undergraduate curriculum or are in the process of doing so. Increased cohesiveness of the curriculum and integration of the overall intellectual experience are the desired outcomes of this move to revamp core requirements.

An example of the specific pedagogical goals being emphasized by contemporary educational reformers is provided in [The University of Maryland] College Park Plan for Undergraduate Education 1988, the agenda for a reform effort now under way at that institution. The goals expressed in that document include "teaching students to extend principle and ideas to new situations, and to new groups of people," "providing students with a sense of identity and purpose, a concern for others, a sense of responsibility for the quality of life around them," "enlivening students to develop humane values, to celebrate tolerance and fairness, to contribute to the social conscience, to monitor and assess private and collective assumptions,...to become aware of the variety of ways of knowing, and to understand one's place in history and in the contemporary world" (College Park Plan for Undergraduate Education 1988:15). In essence, what is being sought is a multifaceted perspective grounded in a conscious analysis of values and an appreciation of the context in which ideas are born and events take place.

Much of the conceptual groundwork for undergraduate general education reform along the lines indicated above already has been laid by those scholars engaged in women's studies and STS over the last thirty years. Not only have the aspects of pedagogy desired for general curricular reform long been emphasized within STS and women's studies, but the commitment to interdisciplinarity evident in these two fields sets an example for students of how information and methodologies of several subject areas can be integrated. Likewise instructive is the ability of both STS and women's studies researchers to identify diversity of perspective within as well as across disciplines and to consider ideas generated outside of academia in their discussions. This flexible, fluid approach to studying a subject aids in breaking down the often ossified barriers between traditional academic fields and leads to an increased "connectedness" which enhances the undergraduate experience. Fostering such connectedness is, and should rightly be, the goal of general curricular reform.

A more tangible and immediate ramification of improved linkages between STS and women's studies is the potential for reform of the science, mathematics, and engineering curricula, both in K-12 and in postsecondary education. The problem of making science, mathematics, and engineering fields attractive to women has been addressed extensively in recent literature. Task forces, pilot programs, and faculty sensitivity sessions have been implemented with the goal of improving classroom climate and permitting women to develop hands-on skills. Much has been written about the need to present science instruction to both sexes in a more meaningful way--to make it relevant to the lives of the students and to emphasize contextual elements.

Just as it has been a goal of many involved in women's studies and the feminist movement in general to improve science, technology, and math education for women, so scientific and technological literacy has been a major goal of STS, and the reform of curriculum to accomplish this goal has been well emphasized.

A significant amount of women's studies research has focused on how women learn, and particularly how they learn and react to science. Mary Field Belenkey (1986) distinguished five different perspectives from which women view reality and draw conclusions, suggesting that women are connected knowers uncomfortable with separate, procedural knowing skills. Chodorow's thesis is that gender–specific ways of knowing can be referred back to early child development, where females remain connected to their mothers while boys strive for independence and separateness (Chodorow, 1978). Sue Rosser has outlined the ways men and women scientists differ in how they perceive a scientific problem, proceed in investigation, and formulate conclusions (Rosser, 1990). Such research is useful for the development of new teaching strategies in science, technology, and mathematics, and these strategies will become increasingly important as efforts to interest more women in science, math, and engineering careers become more intense.

The increased awareness of the social dimensions of scientific and technological discovery resulting from the work of STS researchers can also provide opportunities for reform in science teaching. A shift to discussion of more relevant issues and interjection of contextual information can enhance student understanding of a given scientific or technological subject. Making science more interesting and accessible increases student motivation and improves the chances for a student to feel comfortable and competent with the subject matter.

At the college level, women's studies and STS elective courses serve as useful adjuncts to required courses for science majors, by heightening awareness of gender biases and providing a corrective to too–rigid perceptions of science as a strictly logical, wholly objective process.

Enhanced collaboration between scholars in women's studies and STS studies can have far-reaching consequences. Both fields have developed to the point where collaboration is not only possible but especially advantageous. Fueled by their ideological missions, which inspire a strong desire for reform, and enabled by an ever-growing sophistication in research methodologies, which provides credibility and legitimacy to their programs and to the individuals who work within them, women's studies and STS can together create the meaningful strategies, sense of direction, and momentum necessary for substantive change in higher education.

REFERENCES

Adams, J. (1986, February). One peanut butter sandwich--Hold the bread. Science, Technology, and Society, Curriculum Newsletter of the Lehigh University STS Program, Number 52, pp. 2-8.

Belenkey, M. F., Clinchy, B. M., Goldberger, N., & Tarule, J.M. (1981). Women's ways of knowing: The development of self, body, and mind. NY: Basic Books.

Bugliarello, G. (1986, April). Socio-technology: The quest for a new discipline. Science, Technology, and Society, Curriculum Newsletter of the Lehigh University STS Program, Number 53, pp. 2-5.

Chodorow, N. (1978). The reproduction of mothering: Psychoanalysis and the sociology of gender. Berkeley, CA: University of California.

College Park Plan for Undergraduate Education 1988, University of Maryland College Park, approved by the Campus Senate, March 7, 1988.

Cowan, R. S. (1979). From Virginia Dare to Virginia Slims: Women and technology in American life. Technology and Culture, 20 (1), 51–6.

Cowan, R. S. (1983). More work for mother: The ironies of household technology, NY: Basic Books.

Cutcliffe, S. H. (1989). Science, technology, and society: An interdisciplinary academic field. National Forum, 69(2), 22-25.

DuBois, E. C., Kelly, G. P., Kennedy, E. L., Korsmeyer, C. W., & Robinson, L. S. (1985). Feminist scholarship: Kindling in the groves of academe, Urbana, IL: Univ. of Illinois.

Easlea, B. (1986). The masculine image of science, with special reference to physics: How much does gender really matter? In J. Harding (Ed.), Perspectives on gender and science (pp.132–158). London: Falmer Press.

Ekman, R. (1983). Women and the changing norms of health and disease. In M. Triplette (Ed.), Women's studies and the curriculum: Proceedings of the conference on "Scholars and Women," March 13-15, 1981 (pp. 77-86). Winston-Salem, NC: Salem College.

Goldman, S. L. (1986, April). The quest for STS studies. Science, Technology, and Society, Curriculum Newsletter of the Lehigh University STS Program, Number 53, pp. 8-11.

Hogsett, C. A. & Rosser, S. V. (1983). Darwin and sexism: Victorian causes, contemporary effects. In M. Triplette (Ed.), Women's studies and the curriculum: Proceedings of the conference on "Scholars and Women," March 13-15, 1981 (pp. 67-76). Winston–Salem, NC: Salem College.

Hubbard, R. (1979). Have only men evolved? In R. Hubbard, M.S. Henifin, & B. Fried (Eds.), Women look at biology looking at women (pp. 7-36). Cambridge, MA: Schenkman Publishing Co.

Keller, E. F. (1983). A feeling for the organism: The life and work of Barbara McClintock. NY: W. H. Freeman.

Keller, E. F. (1986). How gender matters: Or, why it's so hard for us to count past two. In J. Harding (Ed.), Perspectives on gender and science (pp. 168-183). London: Falmer Press.

Knapp, E. A. (1984, September). Liberal arts education for the 21st century. Science, Technology, and Society, Curriculum Newsletter of the Lehigh University STS Program, Number 43, pp. 1-5.

Lerner, G. (1981). Teaching women's history. Washington, DC: American Historical Association.

Longino, H. (1983). Scientific objectivity and feminist theorizing. In M. Triplette (Ed.), Women's studies and the curriculum: Proceedings of the conference on "Scholars and Women," March 13–15, 1981 (pp. 33-42). Winston-Salem, NC: Salem College.

Merchant, C. (1980). The death of nature: Women, ecology, and the scientific revolution. San Francisco, CA: Harper & Row.

Nielsen, J. McC. (1990). Feminist research methods: Exemplary readings in the social sciences. Boulder, CO: Westview Press.

Rosser, S. (1990). Female-Friendly Science, NY: Pergamon Press.

Schuster, M. R. & Van Dyne, S. R. (Eds.). (1985). Women's place in the Academy: Transforming the Liberal Arts Curriculum, Totawa, NJ: Rowman & Allanheld, 1985.

Soble, A. (1983). Why should more women be scientists? In M. Triplette (Ed.), Women's studies and the curriculum: Proceedings of the Conference on "Scholars and Women," March 13-15, 1981 (pp. 43-54). Winston-Salem, NC: Salem College.

Stanworth, M. (1987). Reproductive technologies. Cambridge: Polity in association with Blackwell.

Stimpson, C. (1983). Scholarship about women: The state of the art. In M. Triplette (Ed.), Women's studies and the curriculum: Proceedings on the conference of "Scholars and Women," March 13–15, 1981 (pp. 111-122). Winston-Salem, NC: Salem College.

Weinreich-Haste, H. (1986). Brother sun, sister moon: Does rationality overcome a dualistic world view? In J. Harding (Ed.), Perspectives on gender and science (pp. 113-131). London: Falmer Press.

Winner, L. (1986, April). On the foundations of science and technology studies. Science, Technology, and Society, Curriculum Newsletter of the Lehigh University STS Program, Number 53, pp. 6-8.

Chart 1:

PARALLELS IN INTELLECTUAL DEVELOPMENT OF STS AND WOMEN'S STUDIES

WOMEN'S STUDIES*	STS STUDIES
Stage 1: (predisciplinary stage) Identifying historical contributions of women	**Stage 1: (predisciplinary stage)** First discussions of science and technology as social enterprises
Stage 2: (critical stage) Investigating women as a disadvantaged group; criticism of traditional paradigms; women's studies programs established	**Stage 2: (critical stage)** Call for social responsibility of scientists/engineers; criticism of technology; STS programs established
Stage 3: (analytical stage) Analysis of diversities diversities among women; discussion of the variety of female experience	**Stage 3: (analytical stage)** Analysis of cultural, class, racial diversities in assimilation of science and technology; role of values
Stage 4: (integrative stage) Gender as a category of analysis; call for alterations of existing paradigms, integration of feminine perspectives, transformation of curricula	**Stage 4: (integrative stage)** Call for scientific literacy; promotion of public awareness of S/T/S interrelationships; call for curricular reform

*After Schuster, M. R. & Van Dyne, S. R. (1985). Stages of curriculum transformation. In Schuster, M. R. and Van Dyne, S. R. (Eds.). Women's place in the academy: Transforming the liberal arts curriculum (pp. 13-29). Totowa, NJ: Rowman & Allanheld.

Chart 2:

AREAS OF POTENTIAL COLLABORATION

FOSTERING HOLISTIC THINKING

INVESTIGATING THE ROLE OF VALUES

PROMOTING SOCIAL RESPONSIBILITY/RECOGNITION OF DIVERSITY

DEVELOPING INTERDISCIPLINARY METHODOLOGIES

DISCOVERING NEW SOURCE MATERIAL/NEW AVENUES FOR RESEARCH

TECHNOLOGICAL LITERACY AT THE COMMUNITY COLLEGE LEVEL: PEDAGOGICAL METHODS

BY
LOUIS RODRIQUEZ
DEPARTMENT OF HISTORY
LEHIGH UNIVERSITY
BETHLEHEM, PA

We are living in an age in which technology has become so pervasive and so integral a part of our lives that its significance often goes unrecognized. Only when a particular technological system falters do we become aware of its existence. For example, in recent years the world has had to face the environmental consequences of modern technology. These consequences (and related benefits) augment the evidence that technology affects all aspects of social life and vice versa. It would follow, then, that the study of contemporary societies should not exclude study of the relationship between technology and society. Yet, many introductory sociology texts omit technology entirely, or devote only a cursory chapter to it, usually dealing with its effects upon the environment.

The introductory sociology course offers fertile ground for an introduction to technological literacy. Sociological issues such as those involving the family, environment, and education, to name but a few, can easily be integrated with the study of technology. To be sure, there are few sociological topics which are not in some way touched by technology.

During the past few semesters I have taught an introductory sociology course at a community college and I focus on technology as a means of examining just such sociological issues. I do not lecture on the details of technology, rather I introduce it in a simplified way whenever it seems appropriate. By not formally lecturing on technology, I must rely, for the most part, on the student's prior understanding of technology. Discussions arise when, to clarify a point, I find it helpful to draw upon my own understanding of the technological literature. I keep my explanations elementary, however. In what follows I will briefly describe the problems encountered, the readings assigned, and the methods used to integrate technology into such an introductory-level course.

Although community colleges provide an accessible and important source of education for many people, several limitations should be acknowledged. Due to the community college's "open" admissions policy, students reflect a very wide range of preparation. Classes are frequently comprised of students who may have been groomed for college alongside those with a GED. Furthermore, some students will have recently matriculated from high school, while others will not have been in a classroom for decades. In addition, many students have outside commitments, such as work and family responsibilities, which are as important to them as their education. As a consequence, an instructor must work within "unique" limits in structuring him/her class.

At Lehigh County Community College an introductory level sociology course was offered that met for both day and evening sessions. Evening classes met once a week for three-hour sessions, while day classes met twice a week for periods of one hour and fifteen minutes each. The aim of the introductory course was to acquaint the student with the processes that produce, sustain, and change existing social structures. The course also emphasized the understanding of concepts such as social structures, social institutions, and their relationship to emerging, existing, and changing patterns of social behavior.

The primary text for the course was James W. Vander Zanden's Sociology: The Core, second edition (New York: McGraw Hill, 1990). The book's twelve chapters accented key topics such as culture and social structure, socialization, deviance, stratifications, political and economic power, the family, religion, education, and medicine. The omission of a chapter dealing exclusively with technology is noteworthy. There was, moreover, no attempt to integrate technology into any of the topics. Nevertheless, these topics provided ample opportunity to integrate technology into the lectures or discussions.

To supplement the main text, additional readings were offered. Rudi Volti's Society and Technological Change (New York: St. Martin, 1988) was reserved at the library and selected readings from it were recommended. Volti, a sociologist with an interest in the history of technology, views technology as an integral part of society. Society and Technological Change was therefore an especially useful text for integrating technology into a sociology course. In particular, parts three through six, which concentrated on technology and social change in the areas of work, communications, and warfare, were easily integrated with Vander Zanden's work.

To stimulate discussion, students were required to read either the New York Times, the Philadelphia Inquirer, or the Allentown Morning Call for relevant news articles on society and technology. This assignment, in hindsight, was valuable in assessing the students' progress with regard to associating technology with social issues. Initially, students submitted articles on any issue that was of interest to them. During discussion of the articles it was evident that their understanding of the link between technology and society was vague. As the semester progressed, however, they became more aware of this relationship. This awareness was evidenced by the pertinence of the articles and the relevance of the class discussions. Some of the more pertinent articles submitted concerned the Kevorkian suicide machine, the Anglo-French "Chunnel" project, Star Wars, telephones for the deaf, and the French abortion pill.

During the first few weeks the students were casually introduced to the basic tenets of technology. For example, it was suggested to the class that technology was an evolutionary process and not a spontaneous occurrence. The argument was then made that technology was socially constructed, that there was a reciprocal relationship between technology and society. Whenever a specific technology was referred to, I found it best to use one that the students could relate to. This familiarity generally resulted in a livelier discussion. After several weeks of using this procedure to integrate technology into the course, the students began to introduce technology into the discussions without much urging.

When lecturing on the ideas of Comte, Spencer, Marx, Durkheim, and Weber many occasions arose to discuss the role of technology. Durkheim's work on the division of labor in society was especially relevant to discussing industrial technology. (He examined the social structure of early and modern societies and argued that early societies were simple, with little division of labor, in contrast to modern societies which were more complicated.) Technology was injected into the discussion of Durkheim's theory by indicating that the evolution from a simple to a complex society was directly related to technological innovation. This was accomplished by directing the discussion towards the evolution of societies. The evolutionary steps were described beginning with hunter/gatherer and culminating in the post industrial societies. While discussing the evolution of societies, technology's role was underscored. Emphasis was placed on the nineteenth-century industrial revolution, based on the emergence of the factory system and the division of labor, with which most students were familiar. It was then explained how division of labor contributes to technological innovation and vice versa (as such, they perpetuate one another). These factors, it was argued, contributed toward creating a society in which technology has become the dominant factor in social change.

Similarly, when examining concepts such as social mobility, status, roles, labeling, power, and stereotyping it was not difficult to move into a discussion of technology. Clearly, the mass media are the technologies that were most easily integrated into a discussion of the previously noted concepts. Newspapers and television, for example, are the two technologies students often suggested as being most influential in determining and affecting social roles, status, and stereotypes. The students were then directed towards a discussion of how the mass media reinforces stereotypes of minorities and women by depicting them in a prejudicial light. (Almost any program on television can be used as an example.) Once the students were made aware of the media's role in reinforcing stereotypes, the correlation between stereotypes, status, and roles was presented.

In order to expose students to technologies that are not as immediately identifiable as the mass media, they were directed to a discussion of household technologies. It was suggested to them that household technologies, rather than liberate women, have instead isolated and disempowered them by further determining their role, status, and place in society. Among the household technologies utilized to support the argument were the stove and washing machine. To further their understanding of the evidence for this thesis, a depiction of cooking and washing prior to the inventions of the stove and the washing machine was presented. The class, as a result, concluded that the communal nature of wash day allowed women to form relationships outside of the household. From this example the class arrived at a clearer understanding of how technology contributed toward isolating women.

The impact of technology was also useful in helping students to understand Marx's theory of alienation. Technology, it was argued, transformed the work place. No longer were skills required in order to function well at work; machines increasingly replaced skilled craftsmen. To clarify this point, the analogy of a machine that could paint like an artist was used. The machine needed only to be turned on and the paints added or replaced. The students were then asked such questions as: Was it art? Was the machine tender the artist? What were the effects on the artist? Was there any connection between the artist and the final product? By this time the class realized that the same was true of a workman in a factory. Machines have created a gap between man and the product of his labor. The result is alienation.

To stress the effects of the mass media as technologies, it was suggested that the media construct reality and in so doing they construct our society as well. It was further suggested that the media were beholden to sponsors. Then the class was encouraged to consider that the truth was not a paying sponsor. At this point the students could be guided toward the focus of that particular class session, keeping in mind the concepts of truth and reality. For example, if the emphasis was on the concept of anomie, it was not difficult to establish how television, newspapers, and magazines convey conflicting information. This information creates a gap between what is real and what is presented as real resulting in a lack of behavioral guidance or anomie. In consequence, problems result that manifest themselves in various forms, for example, gender and racial tensions.

Among the sociological topics studied, the family seems to offer the best opportunity to discuss the effects of various technologies, because the family is the basis of society. The class was first familiarized with the pre-industrial family, which was depicted as large and extended in contrast to the modern nuclear family. This was followed by a discussion of the industrial revolution and its effects upon the household. The role of technology was then explored. Next, the class began to consider the effects of technology upon the family. Discussions usually centered on such modern conveniences as the telephone, television, microwaves, automobile, radio, computers, and VCRs.

Due to the pervasiveness of the mass media, they were often again the focus of discussion. This has its advantages for the students and for study of sociology and technology. Focus on the media contributed towards enlivening discussion by making the class room material more relevant to the students. In addition, it allowed opportunities for discussion of other technologies. For example, when discussing television the students were made familiar with television's ability to create needs for specific technologies. The class then could argue the merits of that particular technology with regard to the sociological topic studied during that class session.

I found that by the end of the course the students were more aware of the role technology plays in society. This was confirmed by the final exam. I was encouraged by the results and plan to continue employing similar methods. I trust that by treating sociology from the perspective of technology, students will achieve a certain technological literacy. At the least, they will learn that technology plays an important role in modern society.

References

Cutcliffe, S. & Post, R.C., eds. (1989). In Context: History and the History of Technology, Essays in Honor of Melvin Kranzberg. Bethlehem, PA: Lehigh Univ. Press.

Goldman, S., ed. (1989). Science, Technology, and Social Progress. Bethlehem, PA: Lehigh Univ. Press.

Robertson, I. (1989). Sociology: A Brief Introduction. New York: Worth Publishers, Inc.

Vander Zanden, J.W. (1990). Sociology: the Core. New York: McGraw Hill.

Volti, R. (1988). Society and Technological Change. New York: St.Martin.

MUTUALLY ASSURED INSTRUCTION:

TEAM-TEACHING AN INTERDISCIPLINARY COURSE ENTITLED "SCIENCE AND HUMAN VALUES"

Richard S. Demaree, Jr.
California State University, Chico 95929-0515

Ron Hirschbein
California State University, Chico 95929-0730

INTRODUCTION

The seeds of the course germinated in a lively session of an extension course, "Philosophy of the Future." Because of the intense student interest in the implications of science for their future, we responded to a 1981 University request to develop "innovative, interdisciplinary courses." We proposed a course entitled "Science and Human Values." The course is now a General Studies and a Honors class as well as part of an upper division Thematic at California State University, Chico. This paper describes the evolution of the course and analyzes our modest successes and disappointments.

INITIAL OBJECTIVE

Our initial objectives included "critically examining scientific and humanistic sensibilities, and applying them to contemporary social and personal problems." We initially explored three themes:

1. The world views and sensibilities of science and the humanities.
2. Normative approaches to problems engendered by science and the humanities.
3. Case studies such as the epistemological and normative problems engendered by sociobiology.

We used books such as *Brave New World*[1], *The Metaphysical Foundations of Modern Science*[2], *Clashing Views in Controversial Biomedical Issues*[3], readings on nuclear politics, and E.O. Wilson's *On Human Nature*[4].

EARLY SUCCESSES AND FAILURES

During our initial classes we questioned students about the course and invited suggestions. The students were perceptive, and we implemented many of their recommendations.

Brave New World and Piercy's vision of a modest utopia in her *Woman on the Edge of Time*[5] generated discussions about what is in store for humanity with respect to science and human values. Eventually we moved this theme to the end of the semester in order to follow a more logical sequence--past, present and future.

Early on it became clear that there was much confusion about the nature of science and its impact upon everyday life. The students could recite textbook definitions of "science" and "the scientific method" without understanding the subject. Through trial and error, we found that the most effective way to understand science is to trace its origins in philosophy. In order to explore this topic without making it another history lesson, we discussed world views. Student participation was encouraged, and the discussions proved productive. Specifically, we asked students to imagine they were living at a particular time--say the medieval epoch. We asked them to describe how the world would appear through medieval eyes: where would they turn for answers to the most urgent questions; how would they view space and time; and how would they explain natural phenomena? As the course evolved, we came to emphasize the Greek, Medieval, Newtonian and Twentieth Century world views.

The *Clashing Views* . . . . anthology was useful from the start for generating dialogue about the implications of biology. The debate format forced the students to examine contesting perspectives: we asked students to draw their own conclusions about issues such as abortion, euthanasia, genetic engineering, etc. Although students formulated opinions, they had little knowledge of the RESOURCES needed to critically analyze these issues. They were unaware that disciplines such as science, philosophy and theology provide resources for clarifying and--on occasion--resolving such normative problems. Despite our efforts, we were unable to locate a suitable single source of information about the resources essential for resolving the normative problems generated by scientific discovery and technological invention. Thus, we developed our own notions about useful resources and produced our own text.

Turning from the problems engendered by nuclear biology to the monumental difficulties precipitated by nuclear physics (the nuclear arms race), we found that many students prefer not to think about what physicist Herbert York calls, "the race to oblivion."[6] (We recently learned that during my colleague's lamentation about the arms race, a student copied the following phrase in her notebook for fifty minutes: "I don't want to hear this!") We tried anthologies such as *The Ethics of War and Nuclear Deterrence*[7], and debate formats such as *The Nuclear Arms Race Debated*[8], and classics such as *The Fate of the Earth*[9]. None of these works generated enthusiasm despite the relevance of the topic. We hope that my colleague's book, *Newest Weapons/Oldest Psychology....*[10] fares better.

THE CURRENT SITUATION

Several methods are used to evaluate student progress. We give frequent exams--largely short essay. Students also write papers dealing with the nature and impact of science and technology on their lives. They are required to critically examine opposing sides of a topic and to draw their own conclusions (if possible). The oral presentation and the paper that emerge from this inquiry analyze and justify the student's perspective on a controversial issue engendered by the scientific enterprise. (The oral presentation and the ensuing, animated discussion often highlight the semester.)

We trust that the students are receptive to our comments; we are attentive to theirs. Indeed, student comments have had considerable impact in the evolution of the class. They have influenced our format, content and selection of texts.

Despite our modest successes, the students seem to share our view: no single text adequately explores the development of science, the responsibilities of scientists, and the resources available to interpret issues of science and human values. We wrote our own text to fill the void, and we await the comments of our hapless students who are being entreated to a preliminary draft of this text.

CONCLUSION

THE PROBLEMATIC OF INTERDISCIPLINARY, TEAM-TEACHING

We continue to confront nettlesome problems: some seem intractable; others do not. (Within this context, my discussion must be brief and schematic.)

1. MOTIVATION. To be sure, we invariably have a half a dozen students who are actively engaged and struggling to keep us honest. Unhappily, we also have students who bring to mind the Harvard Medical School criteria for brain death--they merely stare and breathe. We struggle to engage these students by throwing them into a situation that demands their active participation. The good news is that we have had modest successes by encouraging students to explore topics that have immediacy and resonance. The bad news is that we have also found it necessary to administer more frequent exams and to call upon students who fail to volunteer. (As products of the Sixties we feel that such tactics are effective but draconian.)

2. ABILITY FOR CRITICAL ANALYSIS. Unhappily, some of the cliches of pop sociology are true: the TV generation is captivated by sensational entertainment, not by sustained, critical analysis of texts. Our response is normally schizoid. We become entertainers when we offer a playful, sometimes dramatic, class in which Rich plays straight man scientist to my caricature of the humanist (the product of some illicit union between William Blake, Jeremy Rifkin and Woody Allen.) Naturally, we also enliven the class through videos and outside speakers. However, we also witness for the seriousness, indeed the deadly seriousness, of our calling. It is no exaggeration to claim that the novel, if not ineffable, problems engendered by nuclear physics and nuclear biology are matters of life and death. Accordingly, our expectations are high, and our critiques of student argumentation and evidence (or the lack thereof) are rigorous. Much to their chagrin, many beleaguered students rewrite their essays to meet our standards.

3. INTIMIDATION BY STEREOTYPES OF PHILOSOPHY & SCIENCE. Some students fear that they must be the proverbial "Einstein" or "rocket scientist" to perform well in our course. No so. The students find our narrative approach accessible and congenial: we suggest that these venerable disciplines of science and philosophy can be understood as stories cultures devise to make sense of their unique experience and place in history. Philosophy struggles in vain to understand the ultimate problems of existence. Yet, the struggle is not without value. Put in the best possible light, it has accomplished the task Clifford Geertz assigns to anthropology:

> The essential vocation of interpretive anthropology is not to answer our deepest questions, but to make available...answers that others...have given, and thus to include them in the consultable record of what man has said.[11]

Science, on the other hand, devises astonishingly successful stories that generate disconfirmable hypotheses for predicting and controlling nature, but it fails to ask--let alone resolve--the captivating, ultimate questions.

Probing into our students' consciousness, sensibilities and everyday existence, we argue that these narratives have become common sense. But, contrary to common sense, common sense is not a coherent, seamless whole. Drawing an analogy from our middle-aged presbyopia, we claim that students see the world through bifocals: they make sense of experience through both philosophical and scientific lenses. They interpret experience from the vantage points of both Aquinas and Newton. Indeed, they simultaneously treasure the solace of traditional religious promises and the productive skepticism of scientific inquiry. Therefore, our course invariably invites the student to look within to understand the conflicting and complementary nature of philosophy and science.

Curiously, we have also noted that the world view endemic to 20th Century physics (a cosmology that has profoundly influenced other disciplines) has not become common sense. Like the populace at large, students have failed to make the "quantum leap" to an indeterminate, relativistic view of the world. To be sure, disciplines such as physics have become arcane and inaccessible to ordinary mortals. However, we sense that students are not receptive even to simplified, provocation renditions of Einstein and Heisenberg. Perhaps they need to cling to the unquestioned, reassuring assumptions of an Aquinas or the absolute verities of a Newton. The world according to Einstein and Heisenberg does not fulfill the religious needs of our students. This quest for absolute certainty stimulates some of our most impassioned--and productive discussion.

REFERENCES

(1) Huxley, A. (1946). *Brave New World*. New York: Harper & Row.

(2) Burtt, E. A. (1980). *The Metaphysical Foundations of Modern Science*. Atlantic Highlands: Humanities Press.

(3) Levine, C. (1981). *Taking Sides: Clashing Views on Controversial Biomedical Issues*. Guilford: Dushkin.

(4) Wilson, E. O. (1978). *On Human Nature*. New York: Bantam.

(5) Piercy, M. (1976). *Woman on the Edge of Time*. New York: Fawcett.

(6) York, H. (1970). *The Race to Oblivion*. New York: Simon & Schuster.

(7) Sterba, J. (Ed.) (1985). *The Ethics of War and Nuclear Deterrence*. Belmont: Wadsworth.

(8) Levine, H. and Carlton, D. (Eds.) (1986). *The Nuclear Arms Race Debated*. New York: McGraw-Hill.

(9) Schell, J. (1982). *The Fate of the Earth*. New York: Knopf.

(10) Hirschbein, R. (1989). *Newest Weapons/Oldest Psychology: The Dialectics of American Nuclear Strategy*. New York: Peter Lang.

(11) Geertz, C. (1973). *The Interpretation of Cultures*. New York: Basic Books.

DESIGN AND IMPLEMENTATION OF AN 'STS' CORE CURRICULUM IN THE HEALTH PROFESSIONS

Robin A. Harvan, Ed.D.
University of Medicine and Dentistry of New Jersey
School of Health Related Professions
65 Bergen Street
Newark, New Jersey 07107
(201) 456-5072

INTRODUCTION

Based upon a recent self-evaluation and a subsequent analysis of external factors affecting its current and future role, the University of Medicine and Dentistry of New Jersey - School of Health Related Professions implemented a broad-based effort to enhance its academic programming. As part of this overall effort, the School developed an interdisciplinary 'STS' core curriculum consisting of six interdisciplinary team-taught and problem-focused courses. Two sequential courses are required of undergraduate students at each divisional level of education (i.e., certificate, associate, and baccalaureate degree). A pilot STS course was conducted in the Fall of 1987 at the baccalaureate (B.S.) divisional level. The overall interdisciplinary core curriculum was implemented in AY 1988-1989 and has remained operational.

CONTEXT FOR EDUCATIONAL REFORM

In 1983-84, under the auspices of the New Jersey State Department of Higher Education, the School conducted a comprehensive institutional self-study (UMDNJ-School of Health Related Professions, 1984). Report recommendations applicable to this project included the following:

- the need to reassess the School's organizational structure, particularly as related to its impact on the quality of academic programming;
- the need for greater clarity, across programs, in the competencies expected of students upon completion of their curricula;
- the need to develop, coordinate and evaluate model efforts at addressing commonalities in student knowledge, skills and sensitivities via shared learning experiences; and
- the need to renew efforts to further the personal and professional development of the School's faculty.

Subsequent analysis of the external context within which the School functions provided a clear focus for addressing these recommendations. At that time, changing perspectives within the higher education community (Association of American Colleges, 1985; Bennett, 1984; Commission on the Humanities, 1980; National Institute of Education Study Group, 1984) supported the need for both increased accountability and greater integrity in the college curriculum. Furthermore, these general perspectives were complemented by an increasing number of calls for reform in the education of health related professionals (Elder, 1985; Kinsinger, 1981, Miller, et. al., 1983; National Commission on Allied Health Education, 1980).

The impact of these changing perspectives on the School's current and future role as a leader in the education of health related professionals was addressed during the Spring 1985 Faculty Retreat. The overall purpose of the Retreat was to clarify faculty expectations regarding needed graduate competencies. Subsequent discussion focused on the reforms in curricula, teaching strategies, and assessment methods necessary to ensure that competencies would indeed be met. Recommendations evolving from the Retreat included the following:

- the School should formulate a generic set of graduate expectations emphasizing commonalities in performance needs across programs;
- the level of performance expected within these common competency areas should vary according to the level of educational preparation provided;
- curricular content, teaching strategies, and assessment methods should be developed and/or refined to address these broadened expectations; and
- such changes should complement, rather than compromise the demonstrated success of the School's programs in preparing proficient health care practitioners.

A GOAL-DIRECTED APPROACH

In response to these tenets, the School implemented a broad based effort to enhance its academic programming to better prepare its graduates for the changing demands inherent in their dual roles as health care providers and members of society at large in the Fall of 1985. The initial project was funded, in part, by a grant from the New Jersey Department of Education's Fund for the Improvement of Collegiate Education (FICE). The project focused upon the identification of generic outcome expectations for entry-level practitioners. This intent was based upon an acknowledged imbalance in the School's programmatic goals and objectives which tended to emphasize the development of discipline-specific proficiencies at the expense of the more generic capabilities common to the needs of practicing health professionals.

Consequently, the faculty developed and adopted a set of generic outcome standards in the Spring of 1987. These outcome standards define, in measurable terms, the knowledge, skills, and sensitivities expected of graduates upon completion of their respective programs of study. The methods employed to estabish the generic goal statements included : (a) a literature review on graduate expectations; (b) a comprehensive programmatic curriculum audit; (c) an outcome priorities perception survey of students, graduates, faculty and employers; and (d) a series of faculty concensus-building workshops. The outcome standards focus upon process and content domain abilities. The process-oriented domain abilities include: (a) critical thinking skills, (b) effective communication skills, (c) self- directed learning abilities, and (d) personal and professional valuing and ethical reasoning abilities. Content-oriented domain abilities focus upon: (a) general knowledge of the role of the humanities and technology in society, and (b) specific knowledge of the health care delivery system.

The establishment of these generic goals prompted the development of the interdisciplinary core curriculum. It was intended that the core curriculum serve as a vehicle for developing student abilites towards the achievement of the School's generic outcome standards. A second component to curricular reform intended that disciplinary programmatic curricula also be redesigned to strengthen these abilities.

CORE CURRICULUM DESIGN

Organizational reforms were implemented by the School in 1986 to accomodate the interdisciplinary STS concept. Academic departments of disciplinary focus were divisionalized based upon educational level and a new Department of Interdisciplinary Studies was established.

The existing core curriculum consists of six core courses administered across the three undergraduate divisional levels of the School. Two sequential 1000-level one-credit courses are offered at the Division of Technical and Specialized Studies (i.e., IDST 1111 and 1212 Health Services Colloquium I and II). This lower division subsumes short term (one year) certificate programming to include the Dental Assisting, Respiratory Therapy Technician, and Surgical Technology Programs. Two sequential 2000-level two-credit courses are offered at the Division of Professional Studies I (i.e., IDST 2111 Dynamics of Health and Society I and IDST 2212 Interdisciplinary Studies Seminar). This division includes associate degree level programming to include the Dental Hygiene, Radiography, and Respiratory Therapy Programs. Similarly, two sequential three-credit courses are offered at the Division of Professional Studies II (IDST 4111 Dynamics of Health and Society I and IDST 4212 Dynamics of Health and Society II). This upper division level subsumes baccalaureate degree level programming to include the Cytotechnology, Medical Technology, Physical Therapy, and Toxicology Programs.

These programs represent six of the School's eight academic departments. The participating programs represent the Departments of Cardiopulmonary Sciences, Clinical Laboratory Sciences, Dental Auxillary Education, Developmental and Rehabilitative Sciences, Nursing Education and Services, and Radiation and Imaging Sciences. The core curriculum is administered and supported by the Department of Interdisciplinary Studies.

Each academic year there are approximately 30-40 students enrolled in the lower division level courses, and 50-60 students enrolled in the four upper divisional level coursework (130-160 students each semester). Therefore, a approximately 150 students are affected by the STS overall core curriculum program.

Whereas, the overall intent of curricular reform was to establish a better balance between the technical and humanistic elements, thereby ensuring that graduates can function effectively within the health care delivery system and society as a whole, the core currculum goals are the following:

- to enhance student awareness about the interrelatedness of the roles of health practitioners in the health care delivery system and society as a whole;
- to relate the insights of the arts, humanities, and social to the personal and professional lives of those in the health service professions;
- to foster skills in critical thinking, effective communication, and self-directed learning within the context of health services and society;
- to stimulate reflection and exploration of personal and professional values and the values orientations of others within a sociocultural context in contemporary society as providers and consumers of health services; and
- to facilitate the attainment and integration of a developmental base of knowledge pertaining to the current perspectives of health, health care and its delivery within the context of a changing society.

The methods employed utilize diverse instructional/assessment strategies and emphasize team-taught problem-solving activities in which students representing various disciplines work together in small groups to critically analyze and address specific problems and issues. These instructional/assessment methods include case analysis, role-playing, "guided-design" problem-solving, observational assessment, values clarification, art/literature critique, "microtheme" writing assessment, video "trigger-tape" discussion, and written examinations.

The content of the interdisciplinary core curriculum focuses on the broad issues common to the role of health care professionals (eg. human/professional values and ethical issues;

current/historical perspectives of the health care delivery system including non-traditional service provision; the economics, equity, and effectiveness of health services; health care policy; the impact of technology on health care and society; and cross-cultural considerations in the delivery of health care services). This topical subject matter is utilized as the vehicle for developing generic process-oriented abilities (eg. critical thinking, effective communication, self-directed learning, personal/professional valuing and ethical reasoning).

Implicit in the structural organization of the core curriculum is the recognized need to "tailor" the divisional curricula of interdisciplinary coursework according to the level of preparation provided. In this manner, the scope and depth with which the interdisciplinary core content is covered can be adjusted according to common levels of performance expectation among similar programs at similar educational levels.

With regard to the content and process domain abilities, this tailoring is achieved by varying the nature and magnitude of learning activities according to prior preparation and ability. By way of example, all students in all divisional levels are required to demonstrate skill in the analysis of oral or written messages (critical thinking/effective communication domains); the nature of the learning stimulus, however, varies according to level of education. Students in the lower division analyze relatively simple communications (eg., mass media messages or organizational directives), whereas students in the upper divisional level analyze more complex messages (eg., research reports or scholarly position papers).

Overall, the empirical support for the curricular model of interdisciplinary problem-focused coursework was provided by Bassoff (1983). Practical guidance in the design of educational experiences for health professional students was provided by Shepard, Yeo, and McGann (1985).

CORE CURRICULUM IMPLEMENTATION

Implementation of the core curriculum was a complex endeavor. Course coordinators were appointed to each division and faculty were recruited from the discipline-specific programs to teach the core courses. Given the number of students participating in the core curriculum (~150), and the methods employed (team-taught, large/small group presentations, discussions, and activities) instructional support needs are intensive. The number of involved faculty range from 10-15 depending upon the number of courses offered each semester, the number of students enrolled in each course, and the number of students assigned to each small group (one faculty leader per group). Initially, faculty recruitment for participation in the core curriculum was on a volunteer basis. Consideration was given on an individual basis for workload adjustments. A seminar was conducted in the Spring of 1987 and repeated in the Summer of 1988 to prepare and enhance faculty's capacities to conduct and teach the core courses.

Overall faculty support and participation was a difficult barrier to overcome. Faculty resistance or lack of commitment is cited as a major obstacle in establishing a viable interdisciplinary curriculum for health professionals by several authors (Infante, Sperenza & Gillespie, 1986; Laasch, Milson & Zimmer, 1986; Sheoard, Yeo & McGan, 1985; Verstraete, Scudder, Karni & Meier, 1978). It was one thing to agree and accept the STS curriculum and generic interdisciplinary focus and quite another thing to relinquish program autonomy with the prospect of core curriculum inclusion.

The two most significant problems to initial implementation of the core curriculum were scheduling and the allocation of time in already full program curricula and the support and participation of faculty. With regard to scheduling, because of the wide variety of participating programs, it was, and still is, difficult to identify a timeframe where everyone is "free". Unfortunately, the STS courses continue to function in "leftover time" in competition with disciplinary program classes and student clinical rotations. Generating proposed solutions to this persistent problem continues despite concerted efforts, although, somehow scheduling is accomplished.

CORE CURRICULUM MAINTENANCE

Curriculum maintenance has been a process of trial and error, evaluation, and continual revision and reform. Emphasis on large assembly presentations for imparting content knowledge was not well received by students in relation to time spent in the small assembly sessions (SAS). A preferred shift of emphasis on small group activities has been a consistent finding in the course evaluations over the past three years. Consequently, more time is spent in conducting the small group sessions.

Most of the activities in the SAS have been successful. Among the most successful were the role playing scenerios in the communication section. This was a consistent finding across the divisional course offerings.

Relevance was and remains a key factor in student acceptance and satisfaction. Generally, students did not like being placed in situations that they could not see as being directly related to practice. At the lower divisional level, relevancy perceptions were more significant across topical areas than at the upper levels. Students in the upper level courses could easily accept notions of professional responsibility, ethical reasoning, and effective communication, but had difficulty accepting such things as the concept of being healthy or of national health economic issues. For the lower level, basic conceptions of health and illness and general knowledge of health care delivery issues are considered equally interesting and important.

As previously noted, the instructional model employed has recognized benefits. The focus on linking process and content abilities utilizing IDS small group problem solving teaching methods was, and still is, believed to be a strength. Divisional segregation is still supported to focusing upon the educational level, hence, level of expected student outcomes.

Other components of success in development include the (a) interdisciplinary team experience, (b) divisional faculty representation, and (c) team teaching approach. Topical content areas originally proposed remain, for the most part, consistant in subsequent offerings.

The enrichment elements previously identified through course/instructor evaluations include the need to develop and enhance faculty capabilities in achieveing content and process learning outcomes. This would include improving content expertise in the broad topical subject areas and in enhancing instructional skills in developing generic process-oriented outcomes (eg. facilitating a moral discussion, assessing writing skills, developing innovative small group activities and assessment methods which link content and process). This may be achieved through various faculty development activities.

In addition, efforts to enhance instructional materials, student activities and assessment tools/methods through research, development and/or aquisition must be accomplished. It also appears that the students' perceptions of faculty authenticity and expertise in select content areas are essential for student acceptance and satisfaction. These areas may be too broad in depth and scope to adequately develop faculty content expertise. It may be more appropriate to invite outside content experts as guest speakers, workshop coordinators, or consultants (eg., hospital CEO, risk manager, quality assurance expert, health insurance underwriter, lawyer, ethicist, health policymaker, AIDS researcher/functioning victim).

Most importantly, a coherent and comprehensive formative and summative evaluation plan needs to be developed and implemented in order to properly analyze the overall core curriculum in terms of its goals, resources, procedures and management. Once operational, this comprehensive evaluation framework could be on-going and self-sustaining in maintaining the curriculum. The implementation of this coherent evaluation design, with a focus on the teaching/learning process, would serve to enhance both the quality of instruction provided and the effectiveness with which learning occurs.

SUMMARY AND CONCLUSION

At this point in our experience, we believe we have managed most of the pitfalls in implementing the interdisciplinary STS core curriculum. With each offering, we have observed increasing student and faculty acceptance and satisfaction. Our successes are that we believe we have made substantial progress in achieveing the goals of the STS core courses. On-going revisions will serve to strengthen the STS educational experience.

REFERENCES

Association of American Colleges. (1985). Integrity in the college curriculum: A report to the academic community. Chronicle of Higher Education, 29(22), 12-20.

Bassoff, B. (1983). Interdisciplinary education as a facet of health care policy: The impact of attitudinal research. Journal of Allied Health, 12(4), 280-286.

Bennett, W.J. (1984). To reclaim a legacy: A report on the humanities in higher education. Washington, DC: National Endowment for the Humanities.

Elder, O.C. (1985). Schools of allied health professions and the future: Report of a delphi study. Journal of Allied Health, 14(1), 25-32.

Infante, M., Sperenza, K., & Gillespie, P. (1986). Interdisciplinary approach to the education of health professional students. Journal of Allied Health, 5(4), 13-22.

Laatsch, L., Milson L., & Zimmer, S. (1986). Use of interdisciplinary education to foster familiarization among health professionals. Journal of Allied Health, 15(1), 33-42.

Kinsinger, R.E. (1981). Allied health education: Challenges for a new decade. Journal of Allied Health, 10, 219-225.

Miller, M.W., Beckham, T.W., & Pathak, D.S. (1983). Mission and goals of allied health education institutions. Journal of Allied Health, 12(1), 11-20.

National Commission on Allied Health Education. (1980). The future of allied health education. San Francisco, CA: Jossey-Bass.

National Commission on Higher Education Issues. (1982). To strengthen quality in higher education. Washington, DC: American Council on Education.

National Institute of Education. (1984). Involvement in learning: Realizing the potential of american higher education. Chronicle of Higher Education, 29(9), 35-44.

Shepard, K., Yeo, G. & McGann, L. (1985). Successful components of interdisciplinary education. Journal of Allied Health, 14(3), 297-303.

University of Medicine and Dentistry of New Jersey-School of Health Related Professions. (1984). Report on the self-study. Newark, NJ: UMDNJ.

ETHICS IN THE TEACHING PROFESSION

NEWTON D. GREGG
Assistant Professor, Engineering Technology
University of Central Florida - Brevard Campus
1519 Clearlake Road
Cocoa, FL 32922-6598
(407) 631-5366

Morality and ethics have consistently been the theme of the National Association for Science, Technology and Society. Ethics has recently been a subject for discussion in the American Society of Engineering Education.

"Morality", as a non-religious conference topic, is usually viewed pejoratively because it is often closely associated with religion. Our pluralistic society accentuates this effect. However, the word "ethics" many times does not adequately describe the problem. Far too often it has a strictly legalistic connotation, with precise meanings perhaps depending on recent court decisions or whether one is speaking as defense or prosecution lawyer.

A dichotomy of these two words could be the subject of a paper but will not be a part of this one. Accordingly, the word ethics will be used for want of a more precise one.

Most discussions of ethics deal with life after graduation - the works of a profession, business or government. This paper deals with the ethics of the teaching profession itself. It is a subject that any teacher could spend some time pondering. After giving the matter some thought the writer has come up with a number of items and has divided them into three broad categories.

The first is standards. Lest some of the other items in this article be misunderstood, this objective should be clearly stated. Any particular class must evoke the teacher's best efforts to get the material across to the students. Integration with other related material and possible use in later life are two aims that come to mind. Each class also has its place in the reputation and standards of the institution as a whole.

One aspect of standards must raise its ugly head in any complete discussion. It is cheating. There can be but one thing to say. It must not be tolerated in any form. This is in fairness not only to the other students but for the offender as well, not to mention the honor and integrity of the school. Of course, every effort should be made to inculcate these principles in the students. However, often it is too late and not the place to do this kind of thing effectively. In any case, there must be eternal vigilance in keeping it out of the classroom.

The second category for ethics in teaching is truth. This may seem strange coming from an engineer. In many classes it is not applicable. The subject matter in a math class is the truth. Truth in today's complex society, even in some scientific subject matter, is often not so easily defined. Two examples come to mind. In business and political science classes, the nature of our government and society is debatable. The instructor should be as objective as possible. The country's system should be presented "warts and all". When this is done fairly and objectively, the writer has no doubt that our system will compare favorably with any in the world. But, more importantly, it will be the most effective way of bringing about constructive changes.

Another controversial subject, usually taught by engineers, is the environment. An example is fuel for powerhouses. All the major fuels, including nuclear, have their good and bad points. Here again, objectivity is very much in order. Other aspects of the environment such as air and water pollution are also controversial and in some cases threaten our society.

The third category might be called care and welfare of the students. They are important. There would be no school without them.

Probably all schools would deny that they have certain classes whose main function is to get rid of students. Yet the opinions of so many alumni and students that they exist make it most probable that there is considerable truth to it. When it is practiced, even subconsciously, it is unconscionable. There are far better ways to limit enrollment. Tenure track teachers who decimate class size through failures should be politely but firmly told that they are on the wrong track. It is more difficult to correct when done by tenured faculty but it can be done. It should be the primary concern of the teacher to get the material across as effectively as possible. Test results should be constantly evaluated to determine presentation failures and to discover better ways of presenting the material. New teaching methods should be explored. Enthusiasm is important. A rising curve of student grades should be the aim within the limits of upholding standards and the vicissitudes of the students.

Another bit of advise might be: give the students a chance. Some teachers give so few tests that the students barely have time to get used to the teacher and the material before it is too late. The writer has seen students completely bomb the first test and then make A's and B's at the end of the term. Of course, this is very pleasing to the students. For the caring teacher it makes it all worthwhile.

The teacher should be available and ready to give advice to the students. Classroom problems might be: (1) too much social life, (2) taking too many courses while working full time, (3) not having taken or learned the necessary prerequisites, and (4) dislike of a course or a whole program.

Playboy (or girl) students will probably not ask for advice and can be easily handled if they do. Other types require sympathy and complete candor. Large classes, schedule, and other duties often may not permit this one on one relationship. It is an ideal; but motivation should at least be there.

One solution to this problem is to bring these problems into lectures. This is particularly true if there are problems affecting a large percentage of the students. Often a few short words can do so much good.

Another factor that sometimes affects teaching effectiveness is an over-emphasis on research. No one can deny the importance of research. Our welfare as a nation, not to mention world competitiveness of our industry, depends on it. However, it should not be forgotten that the primary objective of schools is education of students. Selecting unqualified or uncaring teachers to teach very basic courses is not in anyone's best interests, particularly the students. It is not good from a theoretical or practical standpoint. This is a responsibility of school administrators and it is an important one.

There may have been a time when enrollments were very limited when this type of thing, while not justifiable, could more easily be excused. Schools, particularly engineering, were to some extent thought to be obstacle courses - to test the mettle of students.

In the not too distant future there will be a shortage of college students, especially science and engineering students. Demographic considerations of the types of prospective students available will not permit countenancing this type of thinking.

In conclusion, the writer wants to say that this paper is written from the perspective of an assistant professor of engineering technology (upper level) at a university. Applicability will vary considerably from graduate school to grade school. However, one item is common at all levels of education and that is welfare of the students. Any teacher that does not have this concern should go into another profession.

scientific literacy as its goal and is based on Dewey's philosophy that effective learning is more likely to occur when the material to be learned has a connection to a goal or activity of interest or value to the student. Issues-directed courses in biology and chemistry, and their impact on non-majors, are described.

SCIENCE EDUCATION AND EFFECTIVE LEARNING

Dewey further stated in 1916 (p 158): "Translated into details, it means that the act of learning or studying is artificial and ineffective in the degree in which pupils are merely presented with a lesson to be learned. Study is effectual in the degree in which the pupil realizes the place of the numerical truth he is dealing with in carrying to fruition activities in which he is concerned. This connection of an object and a topic with the promotion of an activity having a purpose is the first and the last word of a genuine theory of interest in education". Although Dewey's message seems simple, it remains grudgingly difficult to implement. **Effective learning is more likely to occur when students want to learn.** Students will want to learn when there is a connection between the "topic" to be learned and "an activity having a purpose".

The role of science as part of a liberal education is widely recognized. Consequently, science requirements exist in most educational institutions. At the college level, courses fulfilling the science requirement are usually left to the disciplinary science departments. This often means that non-majors take science courses developed for science majors or, alternatively, watered-down versions thereof. The reasons for this are at least three-fold. First, developing science courses incorporating current "real world" uses or applications requires research outside the interests of many highly trained, yet very narrowly focused, university professors. Second, there are few or no reward systems for classroom achievements, even when they lead to effective learning. Third, most university science departments feel a strong commitment to majors, but virtually no commitment to non-majors. As a result of these factors rarely were science courses designed specifically to motivate non-majors. Dewey's message was lost and the higher education environment simply did not encourage this type of course. The result has been predictable; a poor record of achievement in science education for non-majors at all educational levels, and an unacceptably high level of scientific illiteracy amongst the general population.

SCIENCE EDUCATION FOR NON-MAJORS

If we accept Dewey's philosophy, then new course development is in order. Course content and approach should first and foremost cause non-majors to want to learn science. Perhaps the way to begin is to ask the more general question: What causes people to want to learn? **A motivation for learning or learning motivator is something, a need or desire, that causes a person to want to learn.** Most learning is motivated by one or more of the following motivators.

1. Desire to achieve a career, personal, or life goal.
2. Desire to understand the detailed principles and relationships within a specific discipline.
3. Desire to enhance knowledge in one's career area.

4. Desire to be personally involved in the learning process.
5. Desire to understand and appreciate the natural world.
6. Desire to be a contributing citizen in society.
7. Desire for personal preservation and well-being.

Which one or more of these motivators for learning can be used with non-majors? All students have majors and hence career interests and goals. Thus motivator one can be used to good advantage if science can be shown to be useful in that pursuit. Most people are curious about the natural world around them (motivator five). All people are citizens, and most acknowledge and respond to their civic obligations (motivator six). Many persons are concerned about the present and potential future condition of the planet we live on (motivator seven). **In summary, then, non-majors should be motivated to learn science when it is presented in a manner to show its relationship to their career, life, and personal goals, the understanding of the natural world, the global environment, or the fulfillment of their obligations to society.**

If the science education goal for majors is mastery, what then is the science education goal for non-majors? The overall goal for non-majors is **scientific literacy**, defined as an understanding of (a) the nature and limits of science, (b) the basic concepts and principles of science, (c) the technological applications of science, (d) the role of science in the decision making process concerning the major societal issues of our time, and (f) the role of science in public policy decisions (Adams, 1990). Although science majors primarily seek mastery, they should also be literate. The key to scientific literacy is, as Dewey (1916, p 155) states: "finding material which will engage a person in specific activities... for the attainment of ends". We feel that these materials lie in issues which invoke one or more of the motivators of learning. This approach to science education is called the **"issues-directed" approach**.

ISSUES-DIRECTED APPROACH TO SCIENCE EDUCATION FOR NON-MAJORS

Definition of Issue

The issues-directed approach to science education acknowledges that motivation leads to more effective learning. Accordingly, it places science in the context of some issue which addresses one or more of the learning motivators. An **issue** is any area, topic, or question which is interesting to and provides the intended audience with a desire to learn. Examples of issues are water pollution, hazardous waste, fitness and nutrition, and genetic engineering. An issues-directed course usually includes several issues. Each issue chosen provides students with a desire to learn the science supporting that issue.

Issues-directed courses are developed using several guidelines. **First**, the issues must interest and motivate students. One of the primary learning motivators is the desire to achieve a career goal. When science is shown to be valuable in this pursuit, effective learning is more likely to occur. This motivator implies that issues be somewhat audience-dictated. For instance, the issue of hazardous waste management is interesting to business students and the issue of gas laws is interesting to respiratory therapy students. The converse would likely not be true. Certain issues such as water resources and health and nutrition, however, have such broad appeal that they are of interest to most audiences. **Thus, the nature and interests of the audience must be taken into consideration in the development of an issues-directed course. The most successful issues are those that address several learning motivators.**

Second, the issues chosen must allow logical presentation of the full scope of the fundamental concepts in the scientific discipline. An issues-directed biology course which does not develop the idea of the cell and its organelles lacks integrity; the same can be said for a chemistry course which fails to develop the idea of reaction rates and reversible reaction equilibrium. Also, issues should be ordered in such a manner that the scientific topics discussed make logical sense and the transitions between the topics are not artificial.

Third, the issues should be interrelated to provide maximum course cohesion . They should blend together in a unifying **course theme - the major notion or topic which threads together the entire course.** For instance, in an issues-directed course covering cosmology, chemical evolution, the origin of life, human evolution, radioactivity, nuclear energy, and genetic engineering, the theme is the fundamental similarity of matter and life in the universe (Adams, Roberts, and Walsh, 1989). Throughout the course, the discussion never strays far from this theme; students always "see the forest for the trees".

Fourth, disciplinary concepts are introduced on an "as-needed" basis. Scientific concepts are introduced only when they are needed to understand and support an issue. It must be recognized, however, that in any discipline a minimum number of concepts must be discussed in order to maintain course integrity and completeness. An issues-directed course must allow these concepts to surface during the course. Concepts beyond the minimum list are developed "as-needed". **To summarize, the choice of issues is critical. They must be interesting, part of an overall course theme, and allow for the logical development of the full range of scientific fundamentals.**

Over the past few years several issues-directed science courses have been developed for general liberal arts and more specific audiences. Through the American Chemical Society, issues-directed chemistry courses have been developed for both the secondary and collegiate levels. Both these chemistry courses are aimed at general audiences and mainly include issues that address learning motivators which relate to understanding the natural world, being a contributing citizen, and personal well-being. Neither of these courses pursues the motivator of career goals to any great degree because of the diversity of their intended audience. The next sections of this paper describe issues-directed chemistry and biology courses whose audience are business students.

ISSUES-DIRECTED CHEMISTRY

Course Issues and Theme

The issues chosen include materials science, energy, and waste management. They are integral and critical to today's manufacturing system environment, a topic business students study early in their education. The manufacturing system embraces all these issues and provides the course theme. The nature of materials used in modern manufacturing, the use of energy in their transformation to products, and the management of wastes produced during manufacturing processes are the three main issues. A fourth issue, the chemical industry, is included to highlight a specific industry most related to the course content, and to provide added opportunity to explore descriptive chemistry. These four issues provide sufficient latitude to allow for the development of the chemical fundamentals normally covered in introductory chemistry. The four course issues are of significant interest to business students since they directly relate to their career goals and contribute to a better understanding of the world around them.

Course Structure and Pedagogy

Each issue is introduced by presenting relevant or emerging technologies. This technique encourages student interest and generates questions whose answers require an understanding of related basic chemical concepts. For example, consider materials science. This issue is initially presented by examining some of the properties and characteristics of new materials used in manufacturing today, such as aerospace composites, high technology ceramics, electrically conducting polymers, and superconductors. Ensuing discussion leads to one of the fundamental principles of modern chemistry: microscopic or molecular structure determines observable or bulk properties. In order for students to understand how polyacetylene conducts electricity, why some ceramics have melting points above 3000 ^{o}C and why polymers such as polyethylene exhibit varying properties (e.g. food wrap and laundry detergent bottles) it is necessary to study the structure and bonding properties of these materials. Thus, the chemical fundamentals of atomic and molecular structure, chemical bonding, and intermolecular forces are introduced on a "need-to-know" basis in the materials science unit. Chemical principles are explored only in response to the examination or analysis of the issue under review. The four course issues, their introductory technologies, and the chemical fundamentals treated under each are available in detail from the authors (Adams).

Reinforcement of the issue under examination is critical. This is accomplished using a **case study** approach. In the materials science segment the case study is polyethylene. Examination of polyethylene begins at the atomic and molecular level, progressing to bonding patterns, production from monomer ethylene, high and low density varieties, and finally to its newest elongated superhigh-strength form. Throughout this examination, concepts such as electronic structure, chemical bonding, intermolecular forces, and the kinetic-molecular theory are developed to explain various aspects and properties of polyethylene, as well as other materials. The issue is materials science, and the specific thread that binds this issue together is polyethylene.

The Clean Air Act of 1990 is the case study for the energy issue. The case study for the waste management issue is the Save Money and Reduce Toxics (SMART) program developed by Chevron, Inc. (1989). In all instances, the case study imparts currency and relevancy to the issue and chemistry being discussed. This reinforces one of the main goals of the course - to instill in students an awareness of the widespread usefulness of chemistry in their personal lives, professional careers, and futures.

Course Materials and Evaluation

The required text is "World of Chemistry" by Joesten et al. (1991). The text is supplemented by handouts from current newspapers and periodicals. Related congressional bills are also distributed and discussed. Spot videos of course-related television news items are regularly shown in class. All these emphasize chemistry as a current, useful, living science as opposed to a science of quantitative formulas and abstractions seemingly unrelated to the real world.

Students are evaluated using examinations and a research project. The examinations contain two question types - recall and synthesis/projection. The recall questions are either true/false or multiple choice and evaluate student retention of the chemical fundamentals. The synthesis/projection questions require essay answers where students are asked to synthesize previously discussed material and use it to project responses to hitherto unaddressed situations. These questions also accomplish the important goal of requiring students to think critically and logically and apply their skills in scientific problem solving.

The research project mirrors the course issues in that it involves a detailed written analysis of a business or industry regarding raw materials used, energy requirements, and waste management practices. Some students investigate generic industries such as steel, rubber, or photography. Others examine specific businesses such as the Grignard Company in NJ and Clean Harbors, Inc. in MA. In all cases students develop research skills in a technical topic and make recommendations for increased profitability, more efficient operations, and more environmentally aware managerial policies for the use of chemical technologies.

ISSUES-DIRECTED BIOLOGY

The introductory biology course has traditionally followed the textbook approach - a series of primary lectures covering all the chapter information, followed by a side lecture on applications. When considering how best to stimulate the interest of business students, several applications of biology lend themselves well: health is of personal relevance to everyone; drugs affect the individual but also have major impacts on society; and biotechnology is considered by many to be America's most promising industry for the 1990's. Therefore, supplementary lecture materials on these topics have been included over the past several years in the introductory biology course. Student responses have been favorable although they did complain that too many "details" were being discussed because they were in the text chapters, not because they were relevant.

Course Structure - Theme and Issues

In 1990 we decided to change the approach radically. We start with a key application - an issue - as a main focus, and develop important concepts of biology during the course of exploring the issue. We threw out the existing introductory biology course and designed a new one. We wanted to construct a course around several key issues related to a central theme, and one which addressed issues of primary student interest. Therefore, we surveyed the 27 students taking biology in Spring 1990, asking them to express their level of interest in 31 biology topics. A 1 indicated greatest interest, a 5 least interest. Nutrition and Health was the topic of most interest, rating 2.1 followed by human senses, human physiology, drugs and cancer. Cell reproduction rated lowest (3.7), with cell structures, mutation, biotechnology applications and DNA and protein synthesis only slightly higher. The survey suggested that a health theme would maximize student interest in the course subject matter. Related issues might include nutrition and fitness, major diseases like cancer and AIDS, and drugs. For Fall 1990, we used a book focusing on those issues, "Your Good Health" by Harvard Medical School (Bennett, Goldfinger, and Johnson, 1987), as the primary text. This book also has a section on the environment and health, so we added that as the fourth issue in the course. Although this book is very readable, it leaves out too much background material, so we supplemented it with a current conventional human biology textbook by Mader (1990).

Course Outline

The four issues treated in this course are fitness and nutrition, major diseases, health, and the environment. Detailed course content is available from the authors (Philips). Key concepts were included as part of our explorations of issues, not as isolated irrelevant topics. For example, rather than a single lecture on the cell discussing all of its parts, as we had done previously, we discussed parts of the cell when they were most relevant: mitochondria as part of the exercise and muscle discussion; the cell membrane in connection with insulin and diabetes, and with drugs and the nerve impulse; and genes with mutations, genetic diseases, and retroviruses like HIV. The laboratory portion of the course did not change significantly, and continues to emphasize the scientific method and collection and analysis of data. Students make a variety of physiological measurements of their own bodies; explore drug resistance in bacteria, drug testing procedures, antibody-antigen, enzyme and ATP reactions, and analyze foods for nutrient content.

Student Response

At the end of the course, we passed out a survey to the 64 students enrolled, asking them to rate topics covered in the course. Students rated marijuana and cocaine as the lecture topic of greatest interest (1.8) and the lowest rated topics - aging and the structure of proteins, fats and carbohydrates, still rated a relatively high 2.7. We certainly succeeded in redesigning the course around topics of greater interest to the students. But did they actually learn more? Babson's college-wide student survey asks students to rate each course on how much they learned and whether the course stimulated their desire to learn. While the sample size is too small and the variability too high for statistical analysis, the average student felt that they were stimulated to learn more, and did learn more, with the issues-directed approach.

In summary, we believe that effective learning requires connecting the material to be learned with the long-term goal(s) and interest(s) of the learner. Providing these connections gives students more motivation to learn, and results in more effective learning. Thus, science courses for both majors and non-majors should be similar in that the science must be connected to one or more learning motivators. For majors, scientific mastery is directly connected to their career goal. For non-majors, career goals are also important, but since these goals are not in science, the approach must be different. The "issues-directed" approach is designed specifically to motivate non-majors to want to learn science. Our use of this approach in biology and chemistry courses demonstrates the effectiveness of this approach for non-science majors.

REFERENCES

Adams, D.L., Roberts, J.L. & Walsh, M. (1989). The individual, science, and the environment - a one-semester thematic course in scientific literacy. Journal of College Science Teaching, 18, 406-411.

Adams, D.L. (1990). Science education for non-majors: The goal is literacy, the method is separate courses. Bulletin of Science, Technology, & Society, 10, 125-129.

American Association for the Advancement of Science. (1990). The liberal art of science: Agenda for action. Washington, D.C.

Bennett, W.I., Goldfinger, S.E. and Johnson, G.T., eds. (1987). Your good health. Cambridge, MA: Harvard University Press.

Boyer, E. (1990). Scholarship reconsidered: Priorities for the professoriate. Washington, D.C. Carnegie Foundation for the Advancement of Teaching.

Chevron, Inc. (1989). Save money and reduce toxics. San Francisco, CA, Chevron, Inc.

Dewey, J. (1916). Democracy and education. New York: The Macmillan Company. (subsequent copyright 1923).

Joesten, M.D., Johnston, D.O., Netterville, J.T., & Wood, J.L. (1991). World of chemistry, Philadelphia, PA: Saunders College Publishing.

Krieger, J. (1990). Winds of revolution sweep through science education. Chemical and Engineering News, 11 June, 27-43.

Mader, S.S. (1990). Human biology, second edition. Dubuque, Iowa:Wm. C. Brown Publishers.

National Science Teacher's Association. (1990). Science teachers speak out: The NSTA lead paper on science and technology education for the 21st century. NSTA Reports!, April/May, 42-46.

Pool, R. (1991). Science literacy: The enemy is us. Science, 251,266-7.

A COURSE
IN
SCIENCE, TECHNOLOGY, AND SOCIETY

Eknath V. Marathé
25 King's Grant Road
St.Catharines, ON
L2N 2S1, Canada
(416)-934-1796

Introduction

Contrary to some predictions that humankind is approaching the end of history - as we move into the last decade of the last century of this millennium - the interaction of a number of powerful forces is pushing our planet towards a post-technocratic, post-industrial civilization which could herald a new and exciting era.

History's next chapter is being shaped by many encouraging events, including: the new detente and the concession by military superpowers of the futility of the arms race; the startling new political dynamics in Europe, the emergence of new economies; the collapse of many authoritarian regimes; the potential of technological advances for coping with the new dimensions of chronic problems; and the increasing interchange of cultures and ethnicities. All of these ongoing processes hold out hope of human societies aspiring to higher standards of living morally and materially.

But at the same time, there are some distressing counterparts to these hopeful trends. The global population is growing by millions each month; by the latest UN estimate, the world will have an additional one billion new inhabitants by the year 2000. And always, the fastest growth rate is in the world's poorest and hungriest places. Consequently, economic imbalances continue to widen the gap between the North and South. Ethnic, cultural, religious and ideological conflicts are degenerating into bloody violence in developed and developing countries alike. Industrial progress is not yet reconciled with global ecology; and technology is exacerbating the inequality in world wealth between the one billion "haves" and the four billion "havenots". In the face of all this, international organizations are showing fatigue in trying to cope with rapid global changes.[1]

A well-educated citizenry is vital to today's world as global village. Its continued advancement is measured by the quality of education its citizens enjoy, because the quality of education has become the signature by which a community can hope to realize the full potential of itself as well as its members. As the educational needs of a society become increasingly crucial to its survival, specific policies must be established to guarantee their satisfaction within the constraints of the ecology.

All education is the consequence of the response of individuals to enabling experiences - experiences provided to the individual and experiences generated by the individual. The experiences should be provided to the students to enable them to accomplish the following goals:

- To discover and explore scientific phenomena;

- To have some experience with the scientific approach to the rationalization of the results of investigations;

- To develop some understanding of the integrity of the process of scientific investigation and through that the integrity of scientific knowledge;

- To develop some understanding of the process of technological innovation and of the productivity of technology;

- To explore the impact of technology and the products of technology on the quality of life and the quality of the environment;

- To develop the interest, competence, confidence, and will to continue to follow, throughout the next half century, scientific and technological developments in the areas related to societal concerns.

- To develop the appropriate technology for the sustenance of the society considering all of its aspects;

- To develop the will and confidence to endeavour to participate critically in the formation of decisions in societal matters involving Science and Technology;

- To develop to some degree an understanding of probability and statistics and the place of both in Science and in the analysis and resolution of societal problems;

- To develop familiarity with the role of computers in the extension of scientific knowledge and technological capabilities;

- To develop the confidence to acquire competence in specific areas of technology closely coupled to the fulfilment of his or her professional responsibilities.[2,3,4]

With the above goals of Science, Technology, and Society Education in mind the following Course of Study have been developed and taught in Ontario, Canada as Ontario Advance Credit (OAC) course, at the final year of a secondary school. It is suggested that this course could very well be taught in the following areas of educative processes.

1. As a mandatory course in preservice education of Science and Social Science Teachers at the Colleges of Education;
2. First year of a College or a University;
3. First year of a Community or Technical College; or
4. As a mandatory course at the first year level of a Business School.

SCIENCE, TECHNOLOGY, AND SOCIETY[5-12]

A SENIOR DIVISION CREDIT COURSE

Prerequisites: **Grade 9 and 10 Science at advance level and one advance level Science course in the Senior Division.**

UNITS OF STUDY	TIME ALLOCATIONS
CORE	
1. THE NATURE OF SCIENCE	**20h**
2. THE NATURE OF TECHNOLOGY	**20h**
3. HUMANS IN THE ENVIRONMENT	**30h**
4. CURRENT ISSUES IN SCIENCE	**20h**
OPTIONAL, LOCALLY DEVELOPED UNIT	**20h**
	110h

NOTE: If a locally developed unit is not done, no more than seven hours should be added to each core unit.

1. THE NATURE OF SCIENCE

An essay on Nature of Science:

Various definitions of Science
Process of Science and the development of scientific theories - Paradigms
Impact of Science on Society, past and present
Scientific Revolutions
Scientific Literacy
Canadian scientists and Canadian Science
Controversy in Scientific Research

Select at least one topic from each of the following lists:

List A

- * The theory of evolution;
- * The development of modern genetics;
- * The phlogiston-oxygen debate;
- * Bacteria as source of disease;
- * A locally selected topic from the life sciences;

List B

- * The atomic model from Democritus to Schrodinger;
- * The development of particle physics;
- * The development of aeronautics;
- * The microchip revolution;
- * The development of the Heliocentric model of the solar system;
- * the effect of Newtonian mechanics on astronomy;
- * A locally selected topic from the physical sciences.

RELEVANT EXPERIMENTS, DEMONSTRATIONS AND PROBLEM SOLVING

PROJECT: SCIENCE FICTION
STUDY OF AN ESSAY ON SCIENCE FICTION
REPORT ON A SCIENCE FICTION BOOK.

2. THE NATURE OF TECHNOLOGY

Essay on Nature of Technology
Various definitions of Technology
History of Technology - Industrial Revolution
Modern Technology
Appropriate Technology
Technology Transfer
Technological Literacy
Interdependence of Science and Technology
Canadian Technology

RELEVANT EXPERIMENTS, DEMONSTRATIONS AND PROBLEM SOLVING

PROJECT ON TECHNOLOGY

3. HUMANS IN THE ENVIRONMENT

Essay on "Environmental Issues"[10]
Environmental Literacy

Select at least _five_ topics from the following list:

- * Atmosphere and Air quality
- * Acid Rain
- * Greenhouse effect
- * World's rain forests
- * Land use
- * Water and Water Management
- * World hunger and Food Resources
- * Population growth
- * Human health and diseases

* Chemicals in Society
* Energy resources

Study of some Federal and Provincial Environmental Laws and Regulations.

RELEVANT EXPERIMENTS, DEMONSTRATIONS AND PROBLEM SOLVING

PROJECT: A CASE STUDY PRESENTATION

4. CURRENT ISSUES IN SCIENCE

Select any two topics from list A and any three or four Modules from the list B.

List A

* Nuclear energy
* Biotechnology
* Arms race
* Transportation
* Chemicals in society

List B

* Electromagnetic Radiation - a part of our life
* Earth's Moon
* Smoke detectors
* Blood
* Comets
* The incandescent lamp
* Our solar system
* Geothermal energy
* Automobile
* Tides
* Cancer
* Computers
* Malaria
* Biological clock
* Human brain
* Physics of sports
* Agricultural Revolution
* Atmosphere
* Lightning
* Human vision
* Sound and noise
* Meteorology
* Atom bomb
* Cybernetics
* Laser - Holography
* Heat pump
* Periodic Table of Elements
* Allergy and Immunity
* Camera optics and Photography
* Cosmology

* Star war
* Satellites
* Coal
* Relativity
* Nuclear winter
* Aids
* Aspirin
* earthquakes
* Fluoridation
* Aging
* Poverty
* Superconductivity
* Science of Chaos
* Tornadoes
* Fuel cells
* Soil
* Viruses
* Robotics
* Hover craft
* Plastics
* Hypothermia
* Eclipses
* Euthanasia
* Catastrophe Theory
* Superstrings and the Search for the Theory of Everything

PROJECT: CLASS PRESENTATION BY A STUDENT OR A GROUP OF STUDENTS ON THE TOPIC SELECTED FROM ABOVE LIST OR OTHER TOPIC OF STUDENT INTEREST.

THE PRESENTATION WILL INCLUDE THE FOLLOWING ASPECTS: **History, Science, Technology, Sociology, Economics, Politics, Philosophy, Energy and Environmental effect.**

EVALUATION: **50-60% Projects, Assignments, Lab reports.**
40-50% Tests, Quizzes, Examinations.

Emphasis should be given on Concepts in hard-core Science, Problem Solving and Decision Making skills.

HIDDEN CURRICULUM

A very important aspect of this course is the development of problem solving and decision making skills. To achieve this during the teaching of this course, the following units are to be implemented, part by part, as the need arises.

5. CASE STUDIES
Basic needs of an individual;
Basic needs of a society;
Technology Assessment;
Hazard, Risks, and their management;
Environmental Assessment procedure;

Brain storming;
Round Table - A way of involving community in the Decision Making process;
Example of a Case Study.

6. MATHEMATICS - A HUMAN ENDEAVOUR

Mathematical literacy;
Basic mathematics;
Binomial Theorem;
Logarithms and Logarithmic scales;
Algorithm
Exponential function;
Functions and Graphs;
Inverse square law;
Probability and Statistics;
Measurements and Theory of Errors.
Computer Literacy

7. CULTURAL LITERACY (WORLD KNOWLEDGE)

What is Cultural Literacy ?
What is included in the Cultural Literacy ?
What is the importance of Cultural Literacy ?
How Culturally Literate Are You ?

8. SCIENTISTS, THEIR LIFE AND INVOLVEMENT IN SOCIETY

REFERENCES

1. United Nations University,(1990). Understanding the 1990s - Shaping History's Next Chapter. Work In Progress. 13(1), 1.

2. Torgerson, D. (1985). The Paradox of Environmental Ethics. Alternatives, 12(2), 26-36.

3. Rubinoff, L. (1985). Beyond the Domination of Nature: Moral Foundations of a Consumer Society. Alternatives, 12(2), 37-48.

4. The World Commission on Environment and Development (Brundtland Report). (1987). Oxford University Press.

5. Ministry of Education,Province of Ontario. (1988). Science In Society, Curriculum Guideline.

6. Marathé, E. V. (1978). A Curriculum Model for Scientific Literacy. Doctoral dissertation, State University of New York at Buffalo. University Microfilm International, No. 7406760.

7. Marathé, E. V. (1983). A Model for Preservice Education of Science Teachers. Proceedings of the International Seminar on Preservice and Inservice Education of Science Teachers. (pp. 141-49). The Weizmann Institute of Science, Rohovot,Israel. Balban Press.

8. Marathé, E. V. (1984). Science and Technology Education for a Sustainable Society. Symposium Papers, Vol.I, 3rd International Symposium on World Trends on Science and Technology Education. (pp. 178-82). Brisbane College of Advanced Education, Brisbane, Queensland, Australia.

9. Marathé, E. V. (1987). Teacher Education Strategy For Science, Technology, and Society Education. Symposium Papers, Vol.2, 4th International Symposium on World Trends in Science and Technology Education. (pp. 788-91). University of Kiel, Kiel, Federal Republic of Germany.

10. Marathé, E. V. (1989). Environmental Issues. Symposium Papers, 5th International Symposium on World Trends in Science and Technology Education. (pp. 11-21). Makati, Republic of Philippines.

11. Marathé, E. V. (in press). Education for Sustainable Development. Proceedings of the World Environment, Energy, and Economic Conference. Winnipeg, Manitoba, Canada.

12. NSTA, (1990). New Position Paper on Science/Technology/Society. NSTA Reports!. April 1991.

WHY DOES JAPAN NEED STS . . . . ;
A COMPARATIVE STUDY OF SECONDARY SCIENCE EDUCATION BETWEEN JAPAN AND THE U.S. FOCUSSING ON STS APPROACH

YOSHISUKE KUMANO
PH.D. CANDIDATE IN SCIENCE EDUCATION
THE UNIVERSITY OF IOWA / MEIKEI HIGH SCHOOL
1-1 INARIMAE TSUKUBA-SHI 305 JAPAN
0298-51-6611

1. OVERVIEW

In 1872 the Japanese school system was established by the Ministry of Education. This was done by the people who studied abroad immediately following the Meiji Restoration. Science methodologies and practices were imported from Germany, England, France, and U.S. and many foreign scholars were invited to practice in Japan. These experiences led us to believe that everything brought from foreign contries was valuable. Nobody recognized that Japan was becoming a world leader in science. The Japanese people continued to study and work to gain prominence-often sacrificing their leisure time.

The Fundamental Law of Education and School Law of 1947 were promulgated under the influence of the U.S. and the 6-3-3-4 organizational system for school was started. Again, Japanese society had to start from the beginning. As during the Meiji era, by a conglomeration of factors necessary to overcome the devastation of war, people did their best for the good of a greater society. These unusual efforts as a nation make the miracle of the current Japanese economic development possible. This is because our citizens believe that we developed, and continue to develop, a sophisticated centralized educational system. However, times are changing; the old days are passing away and Japanese society is being projected into an area where we feel we have little experience to guide us.

Japanese society has many environmental problems which citizens believe are the result of the development of science and technology. In Japan, the National Course of Study is reformed every 8-10 years. The last reform of the National Course of Study was in 1981 for elementary school and in 1982 for upper secondary schools. Educators and citizens not associated with science believed that too much emphasis had been placed on science education. As a result the Ministry of Education felt pressured to amend the National Course of Study and on April 1989 a new National Course of study was agreed upon that deemphasized science and placed more emphasis on social issues focussing on individualization, internationalization, and information literacy. Mr. Nakayama(1988) says that this reform is a type of science-technology-society theme in a Japanese context. Although this reformation has started, Japanese education does not change easily because of intensive competition on the National Entrance Examination for colleges and universities. These examinations are forcing teachers to cover the entire contents of the textbook and to help students understand the basic concepts of science. The science teachers are continuing to follow the 1960s curriculum of the U.S. because the pre-service education at our colleges and universities has not changed significantly over the past 25 years. Furthermore, all our curricula (not only science but other subjects as well) focus on a specific 'Scope and Sequence' where curricula are developed in a spiral structure. This means that we can find the same concepts presented in several different grades. It seems that Japanese science education is ignoring a new philosophy of science and learning psychology and a new sociology of science. Reflecting all of the problems in science education in the Japanese society, I predict that 'A Crisis of Science Education in Japan' will happen within the next ten years. To prepare for the days ahead, a new research program focusing on the current form of the U.S. STS approach must be established. As Dr. Grayson(1984c) stated," For the first time, Japan is in the position of having to advance the state of knowledge, do advanced research, and create its own technologies. Japan must develop a creative, more knowledge intensive industrial structure."

2. INTRODUCTION

Though many outstanding papers have been published by American educational researchers, none has been more influential than those of the United States-Japan Conference on Cultural and Educational Exchange(CULCON). This project was initiated by President Ronald Reagan and Prime Minister Yasuhiro Nakasone in Tokyo in 1983. The director of this project was Dr. Lawrence P. Grayson and the team members were Dr. Daniel Antonoplos, Dr. Nobuo K. Shimahara, Nevzer G. Stacey and Tetsuo Okada(McCurdy & Strassenburg,1986). Since 1983, three CULCON conferences have been held in the U.S. and Japan. The U.S. Secretary of Education William J. Bennett created a summary paper titled,"Japanese Education Today: A Report from the U.S. Study of Education in Japan" prepared by a Special Task Force of the OERI Japan Study Team(1987). With the influence from CULCON to Japanese education, it is important to note that the latest reforms of the Japanese National Course of Study were developed with science-technology-society as the major theme(Nakayama,1988, Jacobson, Takemura et. al.,1987).

There are many problems in Japan concerning science education. The major problems are those which come from the interrelationships among science, technology, and society. People are being inundated with too much information in too short a time. People are getting more individualized and materialistic, and time and space among the people are getting smaller and smaller. We can't predict the physical changes in our environment produced by modern human beings.

The development of science, technology, and society causes an attitude change of teachers and students. You can find most of the teachers saying that students are becoming more individualistic and desiring an easy life. Communication between teachers and students is changing; respect for teachers is decreasing and students are looking at teachers as teaching machines. Young teachers tend to change and to be happy with the easy life,too. These Japanese problems have been found in the U.S. and reformation of education in the U.S. are taking place in all levels. It is needed to review briefly the recent changes in science education in the U.S.

As a result of the Sputnik-shock in 1957, the U.S. passed a public law called the National Defense Education Act(NDEA). Under this law, psychologists and top scientists (not philosophers of science) got together and developed many curricular materials and textbooks(Yager & Penick,1987). The period between 1955-1974 can be called the golden age of science(Kyle,1985). Then came the "Oil Shock" and the emergence of environmental problems. This crisis resulted in a call for a 'return to the basics'(Kyle,1985). There were many attempts at reformation of secondary education which resulted in a decrease in science and an emphasis on the three Rs'. On October 30, 1970, Public Law 91-516, the "Environmental Education Act" was passed. Under this law and the ESEA(Elementary and Secondary Education Act), many projects and programs were developed concerning Environmental Education.

With NSF funds Project Synthesis developed four main goals for science education and included an analysis of future needs(Harms & Yager, 1981). These were personal needs, societal issues, career education/awareness, and academic preparation. These goals are quite suited to a complex society. It is also noteworthy to recognize the EESA(Edcucation for Economic Security Act of 1984) because at this moment the U.S., was experiencing an "Economic Shock". Under this Public Law(which was later amended to be called the Eisenhower Law, 1989) and with NSF funds, there are many programs and projects developed to resolve science education problems in the U.S. Almost every state has initiated reformation of science education in a variety of ways.

The 1980's reformation of education focussing on science, mathematics, and computer science is different from the 1960's and 1970's. Much has been written in support of this latest reformation in the U.S. First of all, philosophers of science education are criticizing science education and urging changes in the curriculum and methodology now used in teaching science(Hodson,1988, Finley,1983, Wallace,1989). Second, learning psychologists have conducted research on student misconseptions which indicate student thinking methods and how they are affected in typical science classes(Osborne & Wittrock,1985). Third, from the sociology of science, there are moves to change science education(Richards,1988). Fourth, we can find a change of attitude of science teachers toward science education goals(Yager & Penick, 1988). Fifth, we note a large change in student attitudes toward science and teachers. Students want to learn more about societal issues and they are tending not to respect science teachers(Yager & Penick,1986, Yager, Simmons & Penick,1989a). In order to overcome these problems in science education, one of the greatest efforts can be seen in Science-Technology-Society(S/T/S) as defined by the NSTA position statement(Yager et.al.,1990).

3. RATIONALES FOR SUPPORTING STS APPROACH

According to The NSTA Position Statement on Science/Technology/Society(STS) (Yager, et.al.,1989), STS defined as:

"STS is the term applied to the latest effort to provide a real world context for the study of science and for the pursuit of science itself. It is a term that elevates science education rhetoric to a position beyond curriculum and the ensuing debate about scope and sequence of basic concepts and process skills. STS includes the whole spectrum of critical incidents in the education process, including goals, curriculum, instructional strategies, evaluation, and teacher preparation/performance. One can not "do" STS by adding certain topics and lessons to the curriculum, course ourline, or textbook. Students must be involved with goal setting, with planning procedures, with locating information, and with evaluating them all. Basic to STS efforts is the production of an informed citizenry capable of making crucial decisions about current problems and taking personal actions as a result of these decisions. STS means focusing upon current issues and attempts at their resolution as the best way of preparing people for current and future citizenship roles. This means identifying local, regional, national, and international problems with students, planning for individual and group activities which address them, and moving to actions designed to resolve the issues investigated. Students are involved in the total process; they are not recipients of whatever a pre-determined curriculum or the teacher dictates. There are no concepts and/or processes unique to STS; instead STS provides a setting and a reason for considering basic science and technology concepts and processes. It means determining ways that these basic ideas and skills can be seen as useful. STS means focusing on real-world problems instead of starting with concepts and processes which teachers and curriculum developers argue in terms of usefulness to students."

It includes a rationale that supports instruction which could be described as the definition of STS. Why do we in Japan need to reform our science education toward an STS Approach? There are basically five areas which support STS:

(1) Rapid development of science and technology causes a great change of society;

(2) Changes in ways of living, thinking, values and attitudes of human beings;

(3) Advancement of science changes the philosophy of science (constructivism), viewpoints of Sociology of science and the definition of scientific literacy with reference to the history of science;

(4) New view points of Learning Theory, and Learning Psychology;

(5) The results of the Iowa Chautauqua Program.

For the first area, it is so obvious that we need not discuss it further. The National Council on Educational Reform explains the situation in Japan as follows(PCER,1985 NCER,1986);

> "Today, on the eve of the 21st century, Japan is facing a turning point--transition in becoming an internationalized society, an information-centered civilization, and developing an "80-year-career" lifestyle. The sophistication of modern science and technology, particularly progress in the field of information technology, will create a demand for people who are highly productive and creative in handling knowledge and sensitive in their

manipulation of it."

For the second area, enormous changes were found in both the U.S. and Japan. For example, students want to study science with reference to real world situations but in general, students tend to dislike science courses(Yager & Penick,1986, Yager,Simmons & Penick,1989). Other changes or problems were found in Japanese society. Children develop rivalries and egotism, lose friendships and become uncooperative. They become passive and not creative(Ryu,1988). Japanese students receive little individual attention(Ziegler,1986). 'Aimless frustration' is expanding among the students which is in direct proportion to economic development(Ohta,1986). Japanese high school students rarely question their teachers' viewpoints and are judged on standardized tests by their memorization of facts and concepts. Japanese high school students do not use the school library creatively to weave together sources of information and formulate their own interpretations(Kirst,1981). As science teachers and science education scholars in the U.S. tend to change toward the STS-oriented goals of science education(Yager & Penick,1988, Mcintosh & Zeidler,1988), Japanese science teachers and scholars in the same field need to change in parallel direction.

For the third area, Hodson(1988) insists from the position of constructivism, that present science education is out of date and teaches incorrect views of science. Methods of science are not definite ones but they are different ones depending on the individual researcher. The truth in science is not an absolute but a changeble one. Also, nearly all experiments are theory-driven. These factors are often ignored in the present science education where there is an emphasis on finding only one right answer. Richards(1988) says the development of science is always effected by the community of scientists and its changing society which have a distinctive bias. The definition of scientific literacy is constantly being revised by two communities of scientists and science teachers(Yager et.al.,1989, Rutherford, et al.,1989)

For the fourth area, Osborne & Wittrock(1985) assert that present science education trains students in the answer which teachers want without analyzing students' preconceptions or misconceptions. The processes of childrens' recognition of nature are quite different than the processes of scientists. It is important to develop necessary frameworks in order to understand certain scientific concepts.

For the fifth area, the outcomes of the Iowa Chautauqua program are supported by the NSF and the Iowa Utility Association. Classes whose teachers have participated in Chautauqua workshops show better results than ordinary classes in the areas of application, attitude, creativity, science process skills, and basic concepts of science(Yager,1988a, Yager,1990).

All of the papers and ideas mentioned above support the need of STS for both American and Japanese science education.

4. RATIONALS FOR REJETING STS APPROACH

In the U.S., several papers have been written which support position one(Kromhout & Good,1983, Good, Renner, Lawsons, & Herron,1985). Following are the summaries of their contents.

(1) In this world, we have many social issues for which science can offer no direct solutions. The STS approach has a tendency to open the science classroom to dangerous manipulation by antiscientific factions and by social activists(Kromhout & Good,1983).

(2) If we use more social issues for understanding science, students will be confused as to what constitutes the basics of science. A body of scientific

knowledge is only understandable when it is studied in a logical and orderly framework(Kromhout & Good,1983 p649).

(3) Since the definition of science is not the knowledge itself, but the quest for knowledge, the definition of science education should be "the discipline devoted to discovering, developing, and evaluating improved methods and materials to teach science, i.e., the quest for knowledge, as well as the knowledge generated by that quest."(Good et.al.,1985, :140)"

(4) "A central concern of science education should be developing a better understanding of how scientists and people in general learn to quest for knowledge in order to help children learn. The major concern of science education researchers should be in identifying those factors which help people learn science; science as defined by scientists, not by sociologically and/or politically oriented observers."(Good et.al.,1985:140)

Concerning item one, Shindo(1990) asserts that "In Japan after the World War II, we had a strong idea that education should not be concerned with values. If we, the educators declare that we are going to educate in the area of values, then, the whole society of Japan could be thrown into great arguments just like Doutoku-Education(Ethics and Manner) arguments." This idea can be found not only from science teachers but most teachers. Under the Fundamental Law of Education of 1947, teacher cannot force students to have certain values in the school. This is an extension of the idea that teachers should be neutral in the classroom. Because of this, science teachers are proud of their subject because they believe that science itself is neutral by nature(realism). There is a danger in holding debates in science classes which could easily become a waste of time if you don't have a proper goals and controls. Also, we always have a fear whether we are moving to a wrong direction(Matsuo, 1990).

It is true concerning items one and two that we need to understand basic concepts of pure science first in the secondary school science and then, applied science and technology can be easy to understand and develop at the university level. In Japan we don't emphasize the study of technology except in technology oriented high schools where most of the graduates go for jobs in industry areas. In Japan, almost all the technologists are educated at the college or university level. The number of bachelor's degrees in engineering awarded in Japan rose from 9,613 to 73,593 between 1955 and 1982, corresponding to a 22,589 to 66,990 increase in the U.S.(Grayson, 1984a).

Concerning item three, there are many science teachers who have similar ideas in Japan. A main reason for this is most science teachers graduate as science majors which means that they never study Philosophy of Science or Nature of Science or Sociology of Science. Most of the Japanese science teachers hold a realist as opposed to a constructivist view of science. (Actually, Japanese science teachers have not even been exposed to constructivism.)

Concernig item five, no one argues with the importance of finding out how students understand the concepts of science. We need to develop a more proper and adaptable learning theory in science education. However, there are other fields of research in science education.

Under the old curriculum reformation in Japan, the Ministry of Education, Science and Culture developed a new compulsory 10th grade science course so-called "Rika-I" meaning science one(1982). Rika-I was a unique subject with a strong focus on the interrelation between humans and nature including basic concepts in order to understand those issues in terms of Physics, Chemistry, Biology and Earth Science. The Japanese Ministry of Education did its best to encourage each teacher to develop original 'hands-on' activities for the 'Rika-I'. In reality 'Rika-I' was the substitute to one or two subjects from among Physics, Chemistry, Biology and Earth Science. High School teachers didn't trust 'Rika-I' for the following reasons; 1) The concepts of science were too shallow; 2) A single high school science teacher could not be expected to feel comfortable teaching all of the fields of science; 3) Most of college or university did not recognize Rika-I as a requirement for a science and technology course of study; 4) It was too time consuming to have 'Rika-I' in the professional high schools because there were so many students who wanted to follow the science or technology course of study at the university level. In 'Rika-I' there was no coverage of the nature of science, very little mention of the history of science and no sociology of science, but was greatly influenced by environmental education. 'Rika-I' was dropped from the latest curriculum during the reformation of the National Course of Study in 1989. But a chapter on 'Man and Nature' was included in every Physics, Chemistry, Biology and Earth Science course. Here is a nice example of how difficult it is to have a issue oriented science course in secondary shool science in Japan.

5. TOWARDS TO THE JAPANESE STS:

Most American scholars cannot readily see the serious problems of Japanese education and they identify the Japanese educational system as one the U.S. should model. But, is that true? Antonoplos(1986) mentions that some of the research on education in Japan has been of dubious quality and that considerable risk in making or adopting generalizable statements from the literature should be recognized. Grayson(1984b) concludes that the Japanese approach may not continue as a fully successful strategy for the future, as the Japanese will be required to develop their own technologies. Continued economic growth may demand significant changes in Japan's present strategies for technological development and, in turn, to its educational system. Grayson's ideas are so reasonable about our science and technology education that the Japanese government needs to consider his points more fully.

Despite the reformation of Japanese National Course of Study(1989), some important points were missing. As mentioned before, Jacobson & Takemura et.al.(1987), Nakayama(1988), and Takemura(1990) explain that the reformation of National Course of Study of 1989 was done with the essence of STS, but they ignored very important areas, namely, the third, fourth and fifth mentioned above. In other words, the direction of the reformation was correct, but essential analysis of the new philosophy of science, new sociology of science, new learning theory or psychology and appropriate instructional strategies were missing. If the latest reformation focused on STS, then why did they have to reduce the hours of science? We need more science, technology, and cooperation with other subjects. My analysis of the 1989-Reformation for the secondary school was simply the reflection of the first and second areas mentioned above. This was the basic idea that 94 percent of Japanese students were going to high school and most of them tended to become unable to understand science; they then tried to change to issue-oriented science. We need to develop a Jappnese STS approach for the Japanese science education with more careful strategies. Here are my recomendations for the improvement of Japanese science edcuation;

(1) Reexamination of the five areas;

(2) Detailed analysis of STS as defined by the NSTA position statement;

(3) Detailed analysis of STS approaches in other countries;

(4) Development of Japanese STS models;

(5) Setting up a Japanese Chautauqua Program with Government support.

By observing the Iowa Chautauqua Program, one of the most important points is that Chautauqua Program never provides concrete models that every teacher has to follow. The leaders believe the STS approach should be unique depending upon the situation and educational environment of each school or student. There is a clear philosophy of constructivism as STS strategies are structured. Here I can predict that Japanese science teachers will like this project because it is a more flexible approach; i.e., they do not have to be perfect from the beginning. Instead teachers and students all together can develop year by year. An STS approach can be seen as using pluralism and constructivism, but not dichotomy. The background of decision-making processes of Asian culture is pluralism. There is a great possibility for STS approaches to evolve among Asian cultures.

More important factors which have to be considered are the five domains which are developed for evaluation of the Chautauqua Program(Mccomas and Yager,1989). They are the Concept Domain(Domain I), Process Domain(Domain II), Creativity Domain(Domain III), Attitudinal Domain(Domain IV), and Application and Connections Domain(Domain V). It is extremely important for Japanese science education to emphasize new evaluation strategies at this time. Then teachers and students can see for themselves the advantages and disadvantages STS provides. Especially for Japanese education, we need to develop the Creativity Domain more since it is so basic to the STS approach.

6. CONCLUSION

As many scholars in education have documented, the Japanese educational model has historic ties to U.S. education. For American scholars of education, the Japanese education system seems like one of the most sophisticated educational systems. But in actuality Japanese education has many problems. The development of science and technology brings new problems to current society, including 'aimless frustration', lack of humanity, lack of confidence and dignity. On the other hand, we need more and more advances in science and technology for a better life. Under the Ministry of Education, Science and Culture in Japan the latest reexamination of our educaton was started in 1983. In 1989 the reformation of the National Course of Education was one of the results of reexamination focusing the interrelation among science-technology-society. But the author found critical deficiency in the Japanese approach with relation to the STS theme compared to the U.S. STS as defined by the NSTA position statement and Iowa Chautauqua Program was examined by the author. What we need for Japanese secondary science education are understanding of philosophy of science, constructivism as a learning model for the teachers, a focus on greater creativity in science and technology, improved attitude toward science and technology, and greater skill with science processes. The Iowa Chautauqua Program is suggested as one of the best models using an STS approach in the U.S. for the further Japanese reformation of science education.

In Japan, we are teaching under the scope and sequence and every grade have minimum concepts which every student has to understand. If we use the STS approach, we need to make sure all concepts are related to the activities proposed. In this sense, the exact same efforts are needed in our science education as the SS&C(Scope, Sequence, Coordination Project) with STS. Also, the Japanese National Course of Study and the standardized examination(National University Entrance Examination) should include the concepts and processes of science, creativity, attitude, and philosophy of science. Then automatically more science teachers will begin to teach these areas.

For nine years, for 10th grade science, 'Rika-I' (integrated science) was compulsory general science focussing on 'man and nature' issues. Ninety-four percent of the students all over Japan have studied science focussing on Environmental Education; but actual classes were not changed much. In order to gear up for the STS approach, there will be much opposition. But if we develop

Iowa Chautauqua-type Programs at teachers colleges, more and more people will join because there are important changes needed for our Japanese future. The 'crisis of science education in Japan' has already started. Scholars of science education need to take action for our future.

APPENDIX (INTERRELATION JAPANESE SCIENCE EDUCATION VS S/T/S)

-S/T/S caracteristics are from Yager(1990).

S/T/S	Japanese Science
CONNECTIONS AND APPLICATIONS	
*Students can relate their studies to their daily lives.	*Few students can relate their studies to their daily lives.
*Students become involved in resolving social issues and see science as a way of fulfilling their responsibilities as citizens.	*Few students can see value in their studies for resolving current social problems.
*Students seek out information and use it.	*Student required to memorize concepts/information studied.
*Student are engrossed in current technological developments and, through them, see the importance and relevance of scientific concepts.	*Few students can see the importance and relevance of scientific concepts with connection to current technological developments.
CREATIVITY	
*Students ask more questions, and these questions are used to develop STS activities and materials.	*Students rarely ask questions;teachers often ignore these questions for course outline.
*Students frequently ask unique questions that excite their own interests, that of other students and that of the teacher.	*Students rarely ask unique questions that excite their own interests, that of other students and that of the teacher.
*Students are skilled in identifying possible causes and effects of certain observations and actions.	*Students and teachers are only interested in causes and effects that can be found in the texts.

S/T/S	Japanese Science
ATTITUDE	
*Students continually offer ideas.	*Students do not generate ideas but accept ones from teacher and texts.
*Students interest increases from grade level to grade level and in specific courses.	*Students interest in science decreases as they get older.
*Students become more curious about the material world.	*Students major interests is how to get high marks on science exams.
*Students see their teacher as a facilitator/guide.	*Sometimes students see their teachers as teaching machines.
*Students see science as a way of dealing with problems.	*Students see science as one of the entrance examination subjects.
PROCESS	
*Students see science processes as skills they can use.	*Students see science processes as skills they have to follow in the lab.
*Students see processes as skills they need to refine and develop more fully for themselves.	*Students see processes as skills only needed in labs and discussions but not for exams.
*Students readily see the relationship of science processes to their own actions.	*Teachers do not focuss on science processes, but use science processes which must be followed without any questions.
*Students see process as a vital part of what they do in science class.	*Students see science processes as steps they must follow without thinking.

KNOWLEDGE

S/T/S	Japanese Science
* Students see science knowledge as personally useful.	* Students see science knowledge as useful only for future examination.
* Knowledge is seen as a needed commodity for dealing with problems.	* Students have no idea how to manipulate science knowledge for problems.
* Learning occurs because of activity; it is an important happening but not a focus in and of itself.	* Learning science is only for examinations.
* Students who learn by experience retain information and can often relate it to new situations.	* After examinations, most of science information is forgotten by the students.

REFERENCES

Antonoplos,D.P.(1986). Japan:Educationally relevant generalizations and inherent research biases; *United States study group of education in Japan,* ED279560,1-15

Bennett,W.J.(1987). *Japanese education today*: A report from the U.S. study of educaton in Japan; Prepared by a special task force of the OERI Japan study team, ED275620.

Education for economic security act(1984). Public law 98-377, Congressional record, Aug.11, 1984

Environmental education act(1970). Public law 95-516, Congressional record, Oct.30, 1970

Finley,N.F.(1983). Science processes. *Journal of research in science teaching,* 20,(1),47-54.

Good,R., Herron D.J., Lawson,A.E. & Renner.J.W.(1985). The domain of science education. *Science education,* 69,(2),139-41.

Grayson,L.P.(1984a). Japan's intellectual challenge. The strategy. *Engineering education*,74,(3),138-146.

Grayson,L.P.(1984b). Japan's intellectual challenge. The system. *Engineering education*,74,(4),210-220.

Grayson,L.P.(1984c). Japan's intellectual challenge. The future. *Engineering education*,74,(5),296-305.

Harms,C.N. & Yager,E.R.(1981). *What research says to the science teachers,* Volume III, Washington,D.C.: National science teachers association. ED205367

Hodson,D.(1988). Experiments in science and science teaching. *Educational philosophy & theory,*20,(2),53-66.

Jacobson,W.J., Takemura,S., Doran,R.L., Kojima,S., Humrich, E., & Miyake, M.(1987). Analyses and comparisons of science curricula in Japan and the U.S., Second IEA science study, ED271395.

Kirst,M.W.(1981). Japanese education. Its implications for economic competition in the 1980S. Phi delta kappan, 62(10),707-708.

Kromhout,R. & Good,R.(1983). Beware of societal issues as organizers for science education. School science and mathematics, 83(8),647-650.

Kyle,W.C.(1985). What became of the curriculum development projects of the 1960's? How effective were they? What did we learn from them that will help teachers in today's classrooms?. Research within reach: science education,3-24.

Matsuo,T.(1990). Fields and methods to form rational sense of values in science education. Science education monthly, 39(1),16-19.

Mccomas,W.F. & Yager,R.E.(1989). The Iowa assessment package for evaluation in five domains of science education. Science education center, The Univ. of Iowa.

McCurdy,D.W. & Strassenburg,A.A.(1986). A United States of education in Japan, Journal of college science teaching, 15(5),478-481.

Mcintosh,W.J. & Zeidler,E.L.(1988). Teachers' conceptions of the contemporary goals of science education. Journal of research in science teaching, 25(2),93-102.

Ministry of Education, Science and Culture.(1982). National course of study for upper secondary schools. Government of Japan.

Ministry of Education, Science and Culture.(1989). National course of study for upper secondary schools. Government of Japan.

Nakayama,G.(1988). Reform of school science curriculum for the 21st century. Science-technology-society theme in Japanese context. Paper presented at the National Science Teachers Association Annual Meeting, ED292668,1-40.

National Council on Educational Reform(1986). Summary of second report on educational reform. Government of Japan.

Ohta,T.(1986). Problems and perspectives in Japanese education, Comparative Education, 22(1),27-30.

Osborne,R. & Wittrock,M.C.(1985). The generative learning model and its implications for science education. Studies in science education,12,59-87.

Provisional Council on Educational Reform.(1985). First report on educational reform. Government of Japan.

Richards,S.(1988). The new sociology of science, Chapter 9. Philosophy and sociology of scienc(pp.197-224).Basil Blackwell.

Rutherford,J.F.et al.(1989). Science for all americans, Project 2061. American association for the advancement of science

Ryu,T.(1988). Developments in high school physics teaching in japan. Physics education, 23(4),218-223.

Shindo,K.(1990). Formation of student's character and sense of values in science education. Science education monthly, 39(1),8-11.

Takemura,S.(1990). A view from Japan on how to improve science education and teacher competencies, Paper presented at the NSTA national convention.

Wallance,B.A.(1989). Choosing reality, New science library shambhala, Boston & Shaftesbury.

Yager,R.E. & Penick,J.E.(1986). Perceptions of four age groups toward science classes, teachers, and the value of science. Science education, 70(4), 355-363.

Yager,R.E. & Penick,J.E.(1987). Resolving the crisis in science education: Understanding before resolution. Science education, 71(1),49-55.

Yager,R.E. & Penick,J.E.(1988). Changes in perceived attitudes toward the joals for science instruction in schools. Journal of research in science teaching, 25(3),179-184.

Yager,R.E.(1988a); A new focus for school science:S/T/S. School science and mathematics, 88(3),181-189.

Yager,R.E., Graham,C.S., Harkness,J.L., Lang,M.G., Masters,M.L., & Maxwell,E.D.(1989). Science/Technology/Society: A new effort for providing appropriate science for all. The NSTA position statement on Science/Technology/Society(STS).

Yager,R.E., Simmons,P.E. & Penick,J.E.(1989); Student perception of the usefulness of school science experiences. School science and mathematics,89(4),313-319.

Yager,R.E.(1990). Instructional outcomes change with STS. Iowa science teachers journal, 27(1), 2-20.

Ziegler,R.J.(1986). An American principal examines Japan's schools. Principal,66(1), 34-36.

SOCIO-POLITICAL DIMENSIONS IN CIVIL ENGINEERING EDUCATION AT THE UNIVERSITY OF THE WITWATERSRAND

R.T. McCUTCHEON

Department of Civil Engineering
University of the Witwatersrand, Johannesburg
Private Bag 3
WITS 2050
Republic of South Africa

Telephone: 0927 11 716-2690

SUMMARY

While South Africa is in transition to a democracy, the ill-effects of forty years of racist law cannot be put right overnight. Democracy alone will not relieve us of urban poverty, inadequate housing and poor infrastructure. Over the next forty years engineers could play a pro-active role in contributing to the resolution of these problems. However, many disaffected communities now reject technical solutions imposed from above and are extremely sceptical of capitalist development. The expansion and maintenance of the industrialised component of the economy requires not only high-tech capabilities but also a flexibility to foster human and physical development amongst the disadvantaged. In this complex context engineers will only be able to contribute if they can combine technical soundness with socio-political sensitivity. While some qualified engineers are adjusting to the new realities, special efforts must be made to educate the coming generation of engineers.

The social dimensions of science and technology have become part of many undergraduate science and technology courses in Europe and America. In this respect engineering in South Africa has only fairly recently acknowledged that this might be necessary. While its starting point was initially an environmental consciousness, lately at least one engineering department has specifically incorporated socio-political concerns.

After an elaboration of the above background, the paper will discuss the various ways in which the social dimensions of engineering are being introduced into the curricula and research of the Department of Civil Engineering at the University of the Witwatersrand.

INTRODUCTION

A year ago on February 2nd, 1990, President F W de Klerk announced that Dr N Mandela would be released. Since then negotiations towards a New South Africa have proceeded fitfully. The process of undoing forty years of racist law is taking place albeit with conflicting views as to both the substance and the pace of change.

In the national and international press the focus is usually upon the political scene (and the accompanying violence). This has obscured consideration of many other important issues. While the creation of a democracy is indeed of paramount importance, "democracy will not relieve us of urban poverty, inadequate housing and poor services".[1] The very attention to the political arena masks the extent to which the effects of the socio-political system created over the past forty years will remain with us for some time to come.

In particular a policy enacted during the early 1950s has had a devastating effect upon technical human resources. The process of socio-economic improvement which should result from a democratic government will be hamstrung for years to come by the socio-technical result of the educational policy founded in 1953 upon statements by the then Minister of Native Affairs (Verwoerd), such as:

> Native education should be controlled in such a way that it should be in accordance with the policy of the state. If the native in South Africa today in any kind of school in existence is being taught to expect that he will live his adult life under a policy of equal rights he is making a big mistake ...
>
> There is no place for him in the European (White) community above the level of certain forms of labour ... for that reason it is to no avail for him to receive a training which has its aim absorption in the European community, where he cannot be absorbed.[2]

This meant that there was, for example, no point in blacks studying mathematics as they would only carry out menial tasks in their working lives.

Apartheid in general, but its education policy in particular, has led to the current racial composition of technical human resources: in South Africa 96 per cent of the engineers and 89 per cent of the scientists are white.[3]

The existing skewed distribution is disturbing; the prospects for the immediate future are even more so. There is one statistic which encapsulates the magnitude of the problem and illustrates the time that it will take the New South Africa to recover from the legacy of apartheid: one mathematics and science matriculation exemption is produced for every 10 000 black school entrants.[4] The end result is that of the 140 000 black matriculants in 1988 only 500 had adequate qualifications for them to be eligible to study either engineering or medicine, a ratio of 280:1. By comparison the overall figure for the United Kingdom is of the order of 40:1.[5]

Thus, although in 1990 35 per cent of the first year students at the University of the Witwatersrand were black, the proportion in engineering is only 19 per cent.[6] For several years now the Faculty of Engineering has had an academic support programme to strengthen the chances of success for disadvantaged (predominantly black) students. The University has recently established a College of Science to enable promising black scholars to bridge the gap between their inadequate schooling and the requirements of the University.

Although various other avenues are being explored to hasten scientific and technological progress in the black community, the number of formally qualified black engineers is so small that for the immediate future the scientific and technological community will be predominantly white.

From a national perspective the lack of formal technical education amongst the black population is the most pressing problem which confronts South Africa in relation to the creation of a scientific and technological capability.

The situation at the artisanal level is as parlous as at the professional. The legacy of "job reservation" has resulted in the building industry having just over 200 apprentices in 1989 by comparison with some

6 000 in 1972.[7] We begin to feel the full force of an ancient text: "visiting the iniquity of the fathers upon the children unto the third and fourth generation of them that hate me".

During the past years the township violence has severely disrupted schooling. The debacle of the most recent matriculation examinations can only exacerbate the lack of a formal technical capability within the black community.[8] In turn this will exacerbate youth alienation and violence. While aggregated unemployment is estimated at about 13 per cent,[9] it is widely reported that unemployment in sections of the black community runs at 30% and in certain townships at 40%.[10] For the year 2000 black unemployment has been estimated at 50 per cent.[11]

Another reflection of a disturbed society may be found in the demographic trends. For forty years the populace has been forcibly restrained in (or removed to) remote rural areas. But this began to crumble in the early 1980s and has increased momentum of late: it has been estimated that in 1980 the proportion of blacks living in the urban areas was 40%; in the space of a mere ten years this has increased to 50% and is projected to be 58% by the year 2000.[12] The repercussions for the main metropolitan and economic centres has been severe. It is estimated that 70 per cent of the 4,8 million people who live in Greater Johannesburg have no electricity and/or running water in their homes.[13]

2. IMPLICATIONS FOR CIVIL ENGINEERING

Surprisingly, the rapid growth in urban population is part of a complex of factors which has begun to make the civil engineering industry conscious of socio-political factors (other than in simplistic terms such as the effect of sanctions).

During the years 1956 to 1976 the civil engineering industry experienced massive growth as the government pumped money into the provision of the infrastructure (roads, railways, airports) required to underpin an industrialising economy. Although industry was hampered by the plethora of apartheid legislation (such as job reservation), it was generally so stretched (and making so much money) that it proceeded as if socio-political issues were outside the bounds of its provenance. This was an extension of the professional view of the need to keep engineering at a safe distance from politics: most civil engineering work (60-70%) comes from the public sector, too close an association with political decision making could be seen as prejudicing one's technical judgement or even lead to suspicion of corruption.

However, over the past ten years, amongst some engineers, there has been a growing awareness of a socio-political component to our engineering work. This has been occasioned by several factors.

During the early 1980s, when the government first realised that it had to improve the urban infrastructure of Soweto, it attempted to carry out a large project - the Greater Soweto Project. Although many millions of rands worth of work were constructed, the project was not as successful as expected primarily because the lack of administrative-, institutional- and community-, infrastructures (i.e. social infrastructures) within Soweto itself, meant that a seemingly straight forward engineering project was constantly bedeviled with problems. The project not only failed to achieve its objectives but the late 1980s saw a refusal by Soweto residents to pay the rates for services about which they had not been consulted.

Similar problems have been experienced in projects funded by the Development Bank of Southern Africa (DBSA) (a development agency modelled on the World Bank which was founded in 1983). Initially the DBSA was primarily involved in "homelands". The problems have been more severe recently now that the Bank has begun to fund projects in black urban areas.

Apart from the lack of a social infrastructure mentioned above there have been considerable difficulties in dealing with the community (What is a community? Who and where are its legitimate leaders? What infrastructure does the community need from both its own and a wider rural-, or urban-perspective?).

Difficulties have been experienced in relation to the definition of standards for infrastructure, the methods of construction (employment creating or capital intensive?), and questions regarding affordability and who pays? Perhaps more disturbing from a technical point of view has been the frequent inability of engineers to re-focus their attention and remain proper engineers (several psychological factors are at work here and it would be worthy of a study in its own right). Difficulties have been experienced in structuring sound technical solutions at an appropriate level.

The major reason for the engineering industry having become more aware of the need for taking socio-political aspects into account, has been the following ironic situation. The severe recession exacerbated by sanctions has meant a considerable decline in first world type civil engineering work (current work load is less than a half of what it was in 1980). However, various government departments, municipalities and independent development agencies have earmarked significant sums of money for low-income housing and the provision of infrastructure in poor urban areas. Yet, before this work can be carried out on a large scale, the problems inherent in the factors mentioned above have to be resolved. Recently the violence has added yet another factor: it is often potentially dangerous to work in many black areas; in some cases it is not even possible to enter the areas at all. Hence the irony: funding is available for work much of which will not be possible until a legitimate government has been established.

3. THE INTRODUCTION OF SOCIO-POLITICAL DIMENSIONS WITHIN CIVIL ENGINEERING EDUCATION AT WITS

It is within the above context that the Department of Civil Engineering at the University of the Witwatersrand has begun to include socio-political dimensions into its curricula.[14]

Throughout the apartheid era the University itself has been in opposition to the Government. Even during the depths of apartheid the Department gained special permission to enrol some black students. However, the University's wider socio-political concerns were not reflected in the curricula of the Department of Civil Engineering. Traditionally the Department concentrated upon providing a technical education for a first/industrialised world market. During the 1960s and 70s the curricula was entirely technical. Our degree is internationally recognised. As recently as 1987 the British Institution of Civil Engineers carried out its periodic review of our course and we once again received accreditation.

Over the past ten years there has been an intermittent debate within the Department regarding broadening the scope of engineering education. One forceful protagonist has pointed out that the better North American Universities now insist upon a 25% non-technical content. The upshot of these discussions has led to the inclusion of material related to the environment (environmental impact) and management (finance, communication skills). Because the inclusion of new material has been in addition to the previous curricula and not in place of, 'broadening' has led to an increased load in a course which was already noted for its high demands upon students.

Over the past few years we have begun to introduce the socio-political dimensions of engineering. The process has been somewhat ad hoc. Nevertheless, the following have been carried out or are in the process of being established:

1. The introduction of some broader design issues in the First Year Engineering and Design course.
2. An optional course in Development Engineering in the Third Year; this course entails both lectures and practical field work (see below) and involves interaction with the University's Rural Facility.
3. An optional course on "Employment Creation in Construction" in the Final Year; this course explores the linkages between technology and employment possibilities.
4. The opportunity for several Final Year students to carry out an Investigational Project in the field of Development Engineering.
5. The opportunity for several Final Year students to carry out a Final Design which has Socio-Technical linkages.
6. Two post-graduate programmes (Municipal Engineering for Developing Communities and Project Management for Developing Communities) in which at least one third of the curricula comprises courses which explore the socio-political-technical interfaces.
7. Post-graduate projects that explore various aspects of these interfaces in greater detail. To date these projects have been carried out entirely on a part-time and student financed basis which has tended to limit the subjects tackled. Even within this constraint I have encouraged the students to concentrate upon the technical issues within the framework of the wider socio-political sensitivity outlined above.
8. A strong connection has been established with the Wits Rural Facility which has been established at Umbabat in the Eastern Transvaal.
9. A programme of relevant post-graduate research has been initiated. Several pieces of research are in progress and funding is being sought for the programme as a whole.
10. The Hydraulics Division is carrying out extensive work in rural Transkei which provides further links with technology and society issues.

Besides the difficulty of finding space in an already over full year plus some resistance from staff whose concerns are entirely technical, there has also been disagreement among protagonists regarding both the content and form of the educational material.

It is precisely this dilemma which made me respond with alacrity to the conference convenor's invitation to attend this conference. It struck me that this gathering would be eminently able to provide guidance for our future endeavours. Given the students' virtually non-existent education in the humanities (most stopped studying history in their first year at secondary school [13-14 years of age]) and the limited time and resources available, a major difference of opinion is whether "serious exposure" type courses are viable and beneficial by comparison with taking one or two "critical" issues and studying them in depth. I favour the former, partly because I believe that, within a short space of time, it is possible to sensitise engineers to the socio-political dimension of engineering and that this is a worthwhile exercise: in the process to make them aware that to become more than merely sensitive is a life-time's tussle. Partly, I find it difficult to identify one or two "critical" issues at the expense of an overview and I am unsure as to whether, with the time and resources available, it is possible to deal with any one issue in sufficient depth to make it academically respectable. For example, at present in the Third Year undergraduate course we have the equivalent of the time available for one first year course in one subject such as English, History or Biology.

It is perhaps worth mentioning that I am remaining in touch with the world outside academia by being involved in various employment creation projects which are currently funded by the DBSA. Here it is interesting to note that work for a pittance has continued despite unrest, the exception so far being a week's stoppage from political violence that resulted in 1 death and 47 burnt huts.[15] Of perhaps equal importance in terms of being aware of the socio-political-technical interface is my involvement, together with a historian, Professor P Delius, in the formation of a small long-term development project in one of the most depressed parts of rural South Africa. As a result of 40 years of apartheid the region is so riven with strife (chiefly lineage vs collaborationists, youth vs age, ANC/UDF vs collaborationists, plus the women and the migrants) that over 3 years we have been unable to foster an "institution" which has the full support of the various communities.

But these conflicts return us to my earlier theme of the sad legacy. I would prefer to close on two more optimistic notes.

For our Third Year Development Engineering Course we have gained agreement between five different organisations that they will incorporate our students into their work for a three week period during the winter vacation. These organisations each have different agendas so that students will have a measure of choice as to orientation (also the thought of forty 3rd year engineering students on their own in the field ...). The organisations are:

World Vision
South African Voluntary Service(SAVS)
Operation Hunger
The University of the Witwatersrand's Rural Facility (Umbabat)
Wilgespruit Ecumenical Centre

During 1990 one of the Final Year Investigational Projects was the design of a drainage system for one of Soweto's notorious squatter settlements (Mshenguville). Two female students opted for the project. The violence that broke out in the townships during February led me to revise their project to "Motivation and Guidelines for the Introduction of Development Engineering".

The students became engrossed in the project. In April they went on an SAVS feasibility study in a remote area and in July spent ten days building the school along with the community and other volunteers. Every year the Department of Civil Engineering holds a competition as to the best report on the Investigational Project and the best presentation of selected projects (to which prominent members of industry are invited). The students, Ms Sylvia Oliveira and Ms Gisela Erasmus, were awarded the highest mark for their report (that might be adjudged favouritism on my part). In the event they won the competition for the best presentation (neither myself nor any member of staff took part in the judging). Their final comments in the report were as follows:

> One of the first feelings we experienced on being exposed to a way of life beyond that of white suburbia was one of intense anger. Anger at being protected from this reality and anger at ourselves for never bothering to find out.
>
> The realisation of the magnitude of input and time needed to have the slightest impact, is crippling. These feelings of despair need to be assimilated (sic) as soon as possible. Remember Ina Perlman's words (the Director of Operation Hunger whom they had interviewed):
>
> "Few people can move mountains you just have to shovel molehills until you've done your bit about clearing the place up."
>
> If others can come to accept this and still maintain hope, then this project will have been a success.

In their foreword, unprompted by myself, they quoted Lord Ashby: "A student who can weave his technology into the fabric of society can claim to have a liberal education; a student who cannot weave his technology into the fabric of society cannot even claim to be a good technologist".[16]

I envisage that our Department will be actively engaged in contributing to the New South Africa for many years to come. I will appreciate discussion in any of the issues touched upon above but I would be particularly grateful for detailed consideration of the major dilemma:

> Serious exposure over a broad front compared to depth in relation to one or two critical issues.

4. CONCLUSION

Above I have described the steps we are making within the Department of Civil Engineering in order to provide a socio-political dimension to their education. I have stressed the dilemma which confronts us.

In closing, however, I would like to point out that this is a relatively minor problem by comparison with one of the major problems which faces South Africa in the sphere of science-technology-society-education: the paucity of black scholars and students who are technically literate. How to improve this situation in the medium term is a matter for an urgent policy which has not yet been devised.

REFERENCES

1. McCutcheon, R., Tomlinson, R. (1990) Editorial, Urban Forum, 1(1).
2. Verwoerd, H. (1954). Bantu Education: Policy for the immediate future Pretoria, p. 24.
3. Cherry, M. (1990). ANC moves on science policy, Nature, 348, 6 December 471.
4. Ibid.
5. Personal communication Professor W.W. Williams to author, 11 February 1991.
6. In 1989 there were only 7 black graduates of a 209 total. However, in one of my post-graduate courses on employment creation 7 out of 10 students were black, including two from City Engineers Departments in Soweto, two recent graduates, one from Anglo American and one from Lesotho.
7. BIFSA, Annual Report, 1990, and personal communication P. Butt to author November 1990.
8. The Star, 8 January, 1971.

---

9. Ligthelm, A.A., & Kritzinger-van Niekerk, L. Unemployment: the role of the public sector in increasing the labour absorption capacity of the South African economy. *Development Southern Africa*, *7*(4), 632.
10. Reilly, G. (1989). "Urban unemployment is rising" *Business Day*, 27 October. Reporting statistics provided at an urbanisation conference at the Human Sciences Research Council by the acting chairman of the Manpower Commission.
11. Fourie, C. (1988). "Life in a shack area" *Prodder's Development Annual*, 39.
12. Tomlinson, R. (1990). *Urbanization in Post-Apartheid South Africa*,. London: Unwin Hyman.
13. The Star Bureau (1990). "Jo'burg standards among the worst", *The Star*, 19 November, p2. Reporting the results of a two year study by the Washington based Population Crisis Committee.
14. Evidence that the Department of Civil Engineering wished to move in this direction may be provided by the appointment of (a) myself, in September 1987, to the post of Professor of Civil Engineering (Project and Construction Management) and (b) Mr M van Ryneveld, in July 1989, part of whose duties are related to Municipal Design for Developing Communities.
15. Power, M. (1990). "Youths threaten to burn refugees", *Sunday Times*, 2 December.
16. Lord Ashby (1963). Technology and the Academics. In J E Gordon, *The New Science of Strong Materials*. Harmondsworth: Penguin.

THE INFLUENCE OF SOCIETY'S VALUES ON THE MATHEMATICS CURRICULUM IN THE U.S. AND FRANCE

Marguerite Gravez
Penn State University
Allentown Campus
6090 Mohr Lane
Fogelsville, PA 18051
215/285-4811

Everybody is tired of the many new reports showing what I would call the knowledge gap between American and Japanese, Korean, etc., students widening. Several waves of educational reforms for K-12 education since Sputnik (a "Nation at Risk" and now "the competitiveness issue", the David Report, etc.) seem to have gone nowhere. Despite the lofty agenda President Bush set with the nation's governors in the Fall of 1989 (he has not shown much interest in education since and now is otherwise occupied) which contained the ambitious item that American students be first in the world in science and mathematics by the year 2000, my pessimism grows deeper and deeper. Monday, November 3, on the "American Agenda", Peter Jennings stated that no educational problems exist that have not been solved by some school or other. No country can boast--and proudly so--of so many innovative teachers and programs who at least for a moment renew enthusiasm and bring better results.

At the joint Mathematics meetings in San Francisco in January of 1991, the most prestigious meetings of the profession, more than 100 reports on innovative teaching methods were presented, a majority of them on some form of small group experiment or writing in Mathematics.

This piecemeal, band-aid approach, though we are trying to give it a state and national umbrella, highlights the fact that American educators and politicians are trying to ignore. The educational history and philosophy of the countries we are comparing ourselves to, differ deeply from our own.

The economic factor also has been exaggerated or even misrepresented as the Hudson Institute Briefing Paper of May 1990, "The Acanemia Deception" by Lewis J. Perelman shows. "America's academic bureaucracy, abetted by a recent report from the Economic Policy Institute, is spreading the myth that U.S. schools are financially undernourished compared to those of other nations. The truth is just the opposite: U.S. spending on education is 'unsurpassed' (as President Bush has said).

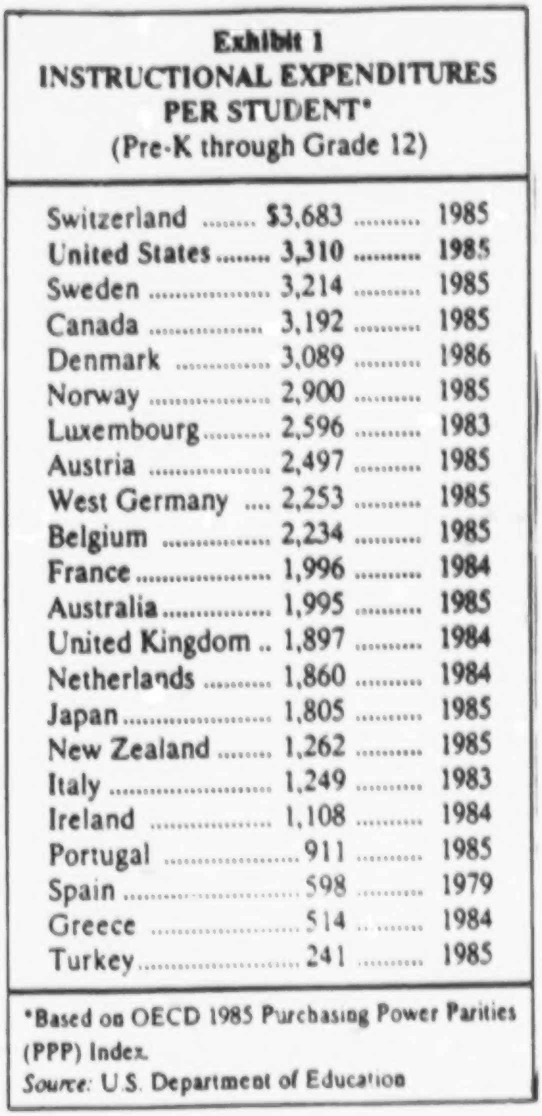


Exhibit 1
INSTRUCTIONAL EXPENDITURES PER STUDENT*
(Pre-K through Grade 12)

Switzerland	$3,683	1985
United States	3,310	1985
Sweden	3,214	1985
Canada	3,192	1985
Denmark	3,089	1986
Norway	2,900	1985
Luxembourg	2,596	1983
Austria	2,497	1985
West Germany	2,253	1985
Belgium	2,234	1985
France	1,996	1984
Australia	1,995	1985
United Kingdom	1,897	1984
Netherlands	1,860	1984
Japan	1,805	1985
New Zealand	1,262	1985
Italy	1,249	1983
Ireland	1,108	1984
Portugal	911	1985
Spain	598	1979
Greece	514	1984
Turkey	241	1985

*Based on OECD 1985 Purchasing Power Parities (PPP) Index.
Source: U.S. Department of Education

The 'lag' in U.S. education is not in spending but in productivity. American schools actually are 'shortchanging' the nation by wasting some $100 billion a year through sprawling bureaucracy and outmoded technology. Increasing budgets for obsolete schools will waste resources and delay the educational restructuring needed to compete in the 21st century economy." We must, however, recognize that at the Ph.D. level, American mathematicians are probably second to none.

Leaving aside cost and thousands of isolated teaching experiments, the fact is as we look at other nations a totally different approach may be required to reach Bush's lofty goals. Can a society's values be changed? Do we really want to turn the American way of life upside down to improve the knowledge base of our students? French children and their parents, as well as Japanese, Koreans, etc., do not grow up believing school (and later on college) must be fun. They expect hard work, discipline, long hours of homework, and very few extracurricular activities. Memorizing, training your memory and learning basic facts that you can store away forever on your own inner PC, will not kill your originality but permit you to progress to new heights. Testing your skills, your knowledge, and finally, even passing the baccalaureate (the dreaded final exam at the end of high school that every French student faces if you have not chosen a technical strand), and permits him or her to attend a university free of charge, may well be more exciting than any football game your school wins.

I am oversimplifying, but parents, community, and society at large, must support history and tradition and push the child in this effort. Is this what we want for our children? Some parents have already answered with a very clear yes. On the other hand, most American parents and educators feel children should not be pressured by long hours of homework and that extracurricular activities play an important role. They resent the implication that students in other countries do better. Our teachers have not been trained to demand the logical and precise way of thinking that other countries require! They have never been exposed to that training themselves. Maybe as early as age 8 or 9, French students have to learn definitions in mathematics and proofs follow very soon. Unlike their American counterparts who have great difficulties with definitions and proofs even in college, French students welcome those questions on tests. Possibly as a result, but more likely because of continuous drilling in the early years, the French child solves "word" problems quite easily as early as the sixth grade. Even our "good" calculus students dislike them intensely. It may well be that as a society we cannot have it both ways and when we have recognized the choice we are facing may stop throwing our money away.

Besides this profoundly different attitude, we must also examine some of the many other factors which characterize the French (and US) systems and impact on the curriculum.

(1) A national curriculum from preschool to the "Bac" enforced by a well trained group of inspectors and year-end exams. How many American schools do not even now have subject-based exams at the end of each grade? How much time, effort, and money could be saved by the states if one group of highly trained professionals established one curriculum for "one nation under God." We certainly do not mind watching the same television programs from coast to coast. There must be so much expensive waste and duplication when 50 states (and bureaucracies) try to solve the same problem!! Let's at least go regional! I am well aware that most Mathematics educators feel that politically a national curriculum is an impossible dream or nightmare! Yet if a national model carefully structured by the U.S. Department of Education and tested in pilot schools across the country would prove to be successful might not the states follow suit. Yesterday, January 31, 1991, in USA Today, Governor Keane and his new group "Educate America" advocated strongly the same national test for all high school seniors.

(2) School boards are purely an American creation and their role should be reexamined.

(3) The position of teachers in American society remains unclear and unsatisfactory, fostered by the profession itself. When a school district interviews a new teacher no mileage reimbursement is offered; very often they

are not even invited to lunch. Compare this to prospective engineers who are wined and dined like kings during their interview. No clearer message could be sent! In France teachers are civil servants employed by the state, who can be sent to wherever they are needed. No office hours, no close contacts with students are required in the upper grades (I am not saying this is a plus). Homeroom and cafeteria duties are handled by paraprofessionals. Thousands of local time and money consuming strikes are avoided.

(4) The virus of student evaluations which has attacked so strongly colleges and universities has I hope not reached K-12 levels (evaluations in French universities: you must be joking). It does affect, however, the training of teachers.

(5) Homework is an accepted fact of life early on, even though the French never went to the Japanese extremes (Saturday school, etc.). William Thurston, in his very comprehensive Treatise "Mathematical Education," regretfully recognizes "in most places it is harder to get students to do homework or study outside the classroom than fifteen years ago."

If the U.S. student is to test first in the world in mathematics, this society may have to make a choice inspired by the philosophy and achievements of the nations we want to emulate. More modest improvements may be possible without disrupting the structure of this nation; a high school population first in sciences may be an impossible dream!! Maybe we can improve on the "Education We Deserve" as stated in the New Perspective Quarterly: "A decade of debate over the declining quality of American education has yielded a singular conclusion: The crisis is not in the schools but in us. The society we have constructed has given us the education we deserve."

ISSUES-DIRECTED SCIENCE EDUCATION - THEORY AND APPLICATIONS IN BIOLOGY AND CHEMISTRY

David L. Adams, Babson College Babson Park, MA 02157-0901

James R. Philips, Babson College, Babson Park, MA 02157-0901

INTRODUCTION

Students enroll in science courses for many different reasons. At the college level, students can be classified as science majors (majors) or non-science majors (non-majors). What are the goals of these two groups when taking science courses? Should they be similar or different? A previous article in this Bulletin argued that the goals for these two groups fundamentally differ and that separate courses are necessary to meet both sets of goals (Adams, 1990). That paper also argued that the goal of science education for non-majors is scientific literacy. Given these premises, then, what is the most effective approach in developing specific courses for non-majors? Some insight into the answer to this question can be gained by examining what makes people want to learn.

Consider the case of science majors taking a science course. Most often, majors plan careers in science or a related area. This career goal provides the motivation and interest for learning science. Majors need and expect to gain a thorough understanding and working knowledge of all aspects, theoretical and practical, of the science. This scientific mastery is essential to their pursuit of careers in science. Scientific mastery, then, is an appropriate goal for science majors. On the other hand, it is an inappropriate goal for non-majors who do not share this career goal and have no motivation to learn the detailed, theoretical features of science.

If mastery does not motivate non-majors in their study of science, then what does? The answer lies in **demonstrating of the role and utility of science in some activity which has interest and value to the student.** This philosophy was enunciated in 1916 by John Dewey (p 155): "The problem of instruction is thus that of finding material which will engage a person in specific activities having an aim or purpose of moment or interest to him, and dealing with things not as gymnastic appliances but as conditions for the attainment of ends". This philosophy has been implemented well for majors, but not for non-majors. Enmeshed in this inability are several troubling issues within the science education community today: (a) the marginally useful science education that most of our secondary and collegiate students receive (American Association for the Advancement of Science, 1990; Krieger, 1990), (b) our societal inability to deal rationally with scientific issues (National Science Teacher's Association, 1990), (c) the national scandal of scientific illiteracy (Pool, 1991), and (d) the university reward system which values disciplinary research over teaching and learning (Boyer, 1990).

The purpose of this paper is to present the theory and practical guidelines of one approach toward motivating non-majors to want to learn science - the "issues-directed" approach. This approach has

BIBLIOGRAPHY

Jennings, P. An American agenda. ABC Evening News, November 3, 1990.

Perelman, L.J. (1990). The acanemia deception. Hudson Institute Briefing Papers.

The education we deserve comment. New Perspective Quarterly, Fall 1990.

I/MG1/121

INTERNATIONAL REPRESENTATION IN SCIENCE TECHNOLOGY AND MEDICINE

Dr. David K. Addae

and

Dr. David L. Lickteig

Box 107 - UAPB
Rust Technology Building
Department of Industrial Technology
University of Arkansas at Pine Bluff
Pine Bluff, Arkansas 71601
(501) 541-6659/6546

Technological illiteracy is a world wide problem. It has been estimated that nine out of ten Americans are technologically illiterate (Miller 1986). If that is true, then what would be the estimate from developing countries, especially African and the Caribbean countries? That means the illiteracy problems is worse in those developing countries where about eighty percent of the population lack of basic education in science, technology and medicine.

The authors of this paper fervently believe that it is necessary to address the technological literacy problem and change the directions of all economics, no matter what the present state of development maybe. It is a practical recognition that the technologically developed and the less developed countries alike stand in need of a new kind of technology. The new technology should be a technology that is in harmony with individual cultures and need to be a technology that will help each culture to understand and control their own destiny. This paper addresses the role that international scientists and technologists should play in solving the serious technological problems in the developing nations. Furthermore, this paper will suggest what actions are necessary to broaden the awareness and participation of the citizens of the developing countries in science technology and medicine. The first part of this paper attempts to define technological literacy. Who is technologically literate and who is not? What is the criteria for measurement? If there is such a thing as technological literacy for the average citizen in a developing nation, then who should be concerned? What would this technological literate know and be able to do? Embedded in these questions are questions about intellectual processes as well as

The second part of this paper focuses on the role of international scientist and technologist and the necessary role to play in educating citizens of the developing nations. Several key issues such as the assistance of the foreign intellectuals in the developed nations are presented to focus discussion.

Technological Illiteracy Problem

The amazing developments in science, technology and medicine in both developed and the developing nations have come as a savior to mankind. However, there are several social and economic problems that naturally accompany these scientific and technological developments. One of the best known social problem is technological illiteracy.

Almost every individual wants to see further developments in science, technology and medicine. Unfortunately many people do not understand or cannot comprehend the existing developments. This problem is popularly referred to as technological illiteracy. In February 1986, scientist and educators from around the United States met in Baltimore at a educational conference focusing on the "technological illiteracy" of the average U.S. citizen. At that conference, the results of a survey conducted by Dr. John Miller indicated that nine out 10 Americans are technologically illiterate (Miller). There remains a big question in everybody's mind as to what is meant by technological illiteracy? Who is technological literacy are remarkably varied. Warnat (1986) wrote:

> Technological literacy has yet to be defined, although it seems to encompass all the literacies - the basic skills, scientific and computer, as well as the humanities and the social sciences- with a broader view of technology incorporating the various emerging information technologies (p. 14).

There is no single definition for technological literacy, if there exists something like that. Robert Marquard (1986) asked: "How does the picture on your television set get there? Can you describe the technology? If that is too hard, how about your telephone? How does it work? John Miller, who conducted the survey for Northern Illinois University's Public Opinion Laboratory indicated: "Many of the people we asked thought telephone signals were amplified through a hollow tube" (Miller 1986).

In the March 20, 1984 issue of Science, Richard C. Atkinson, chancellor of the University of California at San Diego and former director of the National Science Foundation, noted that several recent reports (the Commission on Excellence in education, the Education Commission of the states, the Carnegie Foundation for the Advancement of Teaching, and the national Science Board's Coleman report) concluded that technological literacy needs to be part of general literacy. The Coleman report stressed that technological literacy is quite different from scientific literacy and mathematical literacy. It was noted that an understanding of scientific literacy and mathematical concepts does not automatically result in an understanding of technology. However, in the very next sentence the report states: "Technology is a product of mathematics, science and engineering". Later the report states: "Technology consists of tools, devices and techniques that have been created to implement ideas born of science and engineering" (p. 73).

Most of the people interested in technological literacy, writing about it, talking about and participating in symposia about it are primarily interested in the verbal aspect of technological literacy implies verbal knowledge of, about and for technology literacy, there may be a tendency to overlook a wide range of technological literacy. (Household 1988)

Hersch (1983) pointed out "Dabbing with a few machines is not enough. Technology means using machines and their access to new information to think. It is actually a form of literacy" (p, 27). Technological literacy requires much more than mere acquaintance with information about technology.

In order to comprehend and sort through this information one must be a good reader and interpreter, and also one must be a good thinker. In the case, of, say robotics, technological literacy is not only knowing how to work machines, but how to organize production to attain greatest efficiency. Technological generation must be able to adapt to constant change. Students must possess the disposition for life-long learning (Hersch 1983, pp. 27-8).

Professor Murchland rightly indicated that technological literacy is a prerequisite for active citizenship. "For the primary task of education is to train us to create and control our symbolic worlds, including, of course, the world of technology. This is what literacy means". (Murchland 1982, p.5). Professor Householder defined technological literacy simply as the ability to comprehend physical phenomena and to interact with the material world in ways which accomplish human purposes.(Householder, p. 5)

Technological Literacy in the Developing Nations

Today, it is popular to speak of technological literacy and illiteracy and nobody is offended, and this often becomes a thought-inhibiting rather than a though provoking phrase. Those who are technologically literate often feel they have a lot more to learn. One visualizes the United States as leading the world in the technology field with the rest of the world's countries lagging behind. Surprisingly, it was estimated that nine out of ten Americans are technologically illiterate (Miller 1986).

Developing technological literacy at the cutting edge of technological development is becoming increasingly difficult. This difficulty is greater in the developing countries where about eighty percent of the population is generally illiterate. And most of the high technologies that are being used in these countries where transferred from the developed nations. Every aspect of such technologies is totally foreign to the people who adapted them. Citizens of these countries adapt the technologies eventhough they do not understand the technical components of them.

Developing nations have greatly benefited from scientific and technological developments that were transferred from the advanced nations. In the field of medicine, many medical technologies such as the X-Ray machines, anesthetics, antibiotics, hormone therapy, surgical instruments, nuclear medicine and several latest developments in medicine. Due to the tremendous benefits of contemporary health care, the citizens of the developing nations consider this technological break through as miracles and desire to have more and more of them. These are people who lost most of their dear ones due to patterns of diseases in those countries.

Infections and malnutrition killed many people in infancy or childhood. Other prevalent diseases in most of those developing countries are malaria, tuberculosis, gastrointestinal effects of various types including cholera, typhoid, dysentery, and the less specific infections of smallpox, bilharziasis, yellow fever, measles, scarlet fever, and whooping cough (Pytlik 1978, p. 235). These diseases were easily transferrable with low participating technologies.

In the field of science and technology, many of the leaders of the developing countries always consider constant importations of technologies from the developed nations as the only means of economic development. They always believe that the transfer of the latest developments will assist in increase productivity in their industrialization efforts. The amazing developments in microprocessors computer aided manufacturing, robotics and other forms of automation and cybernetics are considered to be the shortest route to attain economic development.

Nobody disputes the benefits of modern science and technology in the developing countries. They need them to sustain their lives. Let us consider benefits of the birth control pills, high yield grains, quality clothes, dams, bridges, health care, radio and television. Also the benefits of new social technologies, such as banking systems and management information systems. The concern generally is the understanding and comprehension of these systems and their social impact on quality of life in the developing countries. The citizens of these countries need to be educated in order to benefit totally in developing and adapting the technologies that are appropriate to their needs. These appropriate technologies will not be based on a rejection of all that modern science and technology have provided; there is no question of turning back to primitive technologies. The technologies appropriate to the new generation will require the very best that human skill and ingenuity can contrive but they will be conditioned by a different set of priorities under which many of the present unsatisfactory characteristics will be discarded.

The most crucial need for developing countries now is to restructure their educational systems which will address the issue of technological literacy. This calls for a complete new technology education curriculum that would involve the international scientist, technologist and medical professional. The new curriculum should embody the use of hands-on laboratory activities which will provide learning experiences that allow students to examine and learn about science and technology and their differences in a technological society.

The Role of International Scientists and Technologists in broadening participation in Science, Technology and Medicine in the developing countries

In order to address the issue of technological illiteracy in the developing countries, the intellectuals from those countries must play a major role in educating the masses to be in a position to comprehend and adapt whatever technologies they have to adapt.

Ley (1987) has pointed out the critical international importance of technological literacy:

> The level of technological literacy to which educators and others are able to bring the general population will determine the future world in which humankind will exist. The more technologically literate the people of the world become, the greater the likelihood of a future with a humane, optimistic outlook. (pp. 7-8)

The design of an educational system to develop of technological literacy in the developing countries is a complex task since the technology levels cannot easily be defined. It is however, a critical and necessary role for the intellectuals from the developing countries to design a technology education curriculum for the younger generations.

Dr. Paul DeVore rightly indicated that the critical issues facing the world today are technological issues. Thus, the study of technology is essential to the education of citizens in free societies if they are to be responsible and contributing members of their societies. Technology is central because it is the study of human endeavors in creating and utilizing adaptive systems or technical means including tools, machines, materials and techniques - the specialization field of technological endeavors - and the relationship of the behavior of these elements and systems to humans, the social order and the life-giving and life sustaining environment. (DeVore 1986)

It is fairly certain that the future will not vary much like the recent past or the present, therefore children of the developed countries need to be prepared from the early age to be adaptable. The technology education curriculum should aim to help children in the developing countries to understand some important things about the technological society in which they are growing up and, in particular, about its strengths and weaknesses.

Appropriate technology is a basic concept in international technological literacy. In order to use appropriate technology, one must be aware of the options which are available and be able to select the most appropriate from among them. It is not simply fair, from humanistic point of view, should develop appropriate technologies which are in harmony of their cultures. They must have exposure to varieties of the technologies to be in position to decide what will be appropriate based upon the availability of human and natural resources of their environment.

If the concept of appropriate technology and technology education is ideal, then the international scientist, technologists and medical professionals from the developing countries must play a major role in education the citizens of their respective countries in numerous disciplines and curriculum areas. This paper refers to the international scientists, technologists and medical professionals as those intellectuals who migrated from their various countries and were educated in the affluent nations and chose to live and work in the developed nations. Under the circumstances it is understandable why many of the young, ambitious scientists, technologists, engineers and medical professionals decided to emigrate from the developing countries to the advanced countries. However, the authors of this paper believe that those professionals can still play a role in assisting their own countries in providing technology education to the younger generation and the society.

One of the suggested methods that international intellectuals can use is to form associations in the various disciplines and assist their home countries in developing technology education curriculums in the developing nation. If these intellectuals can organize themselves in an appropriate manner, they most likely can have a very good chance in representing, and broadening participation in science, technology and medicine.

REFERENCES

Addae, D. and Lickteig, D., (1988), Government Policy and Its Implications Involving the Adaption of Appropriate Technology in the Less Developed Countries. Technology Education (Symposium Proceedings), St. Cloud State University, St. Cloud, Minnesota.

DeVore, P.W., (1980), Technology: An Introduction. Davis Publications, Inc., Worcester, Massachusetts.

DeVore, P.W., (1987), Science and Technology: An Analysis of Meaning, Journal of Espilon Pi Tau, Vol. 13, pp. 2-9.

Herrara, A.O., A New Role for Technology, Mazungira 8, pp. 35-40.

Hersch, R., (1983), Are American Schools Turning Out Technopeasants? Instructors and Teacher. Vol. 92.

Jequire, N., (1977), Appropriate Technology Problems and Promises (Organization for Economic Development), Paris, France.

Ley, C.J., (1987), Preliteracy, Postliteracy and Investigative Imperative for Vocational Education Researchers. Journal of Vocational Education Research. Vol. 12.

Mesthene, E., (1986), The Role of Technology in Society: American Association of Advancement of Science, St. Martins' Press, New York, N.Y.

Miller, John, (1986), Technological Literacy of the Average, U.S. Citizen - The Christian Science Monitor.

Murchland, B., (1983), Citizenship in Technological Society: Problems and Possibilities. Journal of Teacher Education, Vol. 34.

Murchland, B., (1982), Technology, Liberal Learning and Civic Purpose. Liberal Education, Vol. 68.

Pytlik, E., Lauda, D. & Johnson, D., (1978), Technology, Change and Society, Davis Publications, Inc., Worcester, Massachusetts.

Spencer, D., (1970), Technology Gap In Perspective: Strategy International Technology Transfer. Spartan Books, New York, N.Y.

Teich, Albert H., (1986), Technology and the Future, 4th Edition, St. Martins Press, New York, N.Y.

Warnat, W.L., (1983), The Challenge: Developing Technological Literacy in Education. Paper presented at the Science and Mathematics Education Needs Assessment Conference, Ypsilanti, MI, (ERIC Documents Service No. ED234 012).

RESEARCH, INNOVATION AND PROJECT WORK IN SECONDARY SCHOOLS - EFFECTIVE STS EDUCATION

Srečo Zakrajšek
Zavod Sr Slovenije za Šolstvo
YU- 6100 Ljubljana
Poljanska 28

The quality of education and instruction with young people on research, innovation, and project work has become one of the fundamental orientations of modern society in Slovenia [Yugoslavia]. STS education is very appropriate for this kind of modern education, because of its flexibility and different up-to-date topics which can be adapted to different plances and situations. STS education is also highly motivating for young people and teachers. This is particularly important in small republics like Slovenia.

The Republic of Slovenia, with two million inhabitants in an area of 20,251 square kilometers and with practically no energetic or raw material sources, early recognized its only chance for success in the developing world lay in maximum development of its intellectual potentials. A series of attractive programs were developed spanning business, high technology, ecotechnology, and tourism.

Due to the extremely sensitive political and ecological position of Slovenia, each Slovene student should receive basic STS education. In this connection research, innovation, and project work, based on different integration problems, has been recognized as a most effective one. Our work, started twenty years ago, is based on a number of theoretical issues and practical solutions.

Research and innovation work is part of regular educational programs in secondary schools in Slovenia. The parallel to it - an adequate system of teacher education - is under development. Research and innovation work has become an integral part of everyday pedagogical practice and in some segments, also an integral part of regular or extra curricular activities. The research work is carried out in the framework of obligatory work practice. The research work, has in this way, overcome its initial theoretical conception. The research and project approach has influenced the whole system of laboratory and seminar work, the conception of extra curricular activity, out of school activities, research during vacation periods, natural science days, and elective subjects. The expert literature, necessary for the above mentioned activities, is supplied by a number of specialized firms.

Some private educational agencies, universities, and research institutes have developed a variety of research programs. These programs are of two to three weeks duration and cover themes such as bases of research work, information as a knowledge resource, observation as a knowledge resource, methods of research work, seminar work, and preparation of reports.

All of these programs are integral parts of a complex social development program in Slovenia. As a result, Slovenia has developed a strong research potential, capable of establishing a relatively close relationship with contemporary cultural, political, and economic trends in the developed world.

The work of young research workers and innovators and their mentors has been rationally incorporated into the work of research departments in industry, universities, and institutes. Through these forms of collaboration, a constant transmission of knowledge and cadre policy has been achieved. There is also an optimal possibility for young students and their mentors - secondary school teachers - for the acquisition of master and doctoral degrees. More than 1000 students and over 300 mentors are included in this program every year.

Special research and development laboratories and production units have been developed within the framework of regular secondary school curriculum. They enable a direct transmission of reserach findings into practice. Some programs in the areas of water and air pollution, human health, and similar topics have been developed for student use by the state.

Different kinds of research and project work have been developed for the program leading to the award of the International Baccalaureat to selected secondary students. This International Baccalaureat is an international standard by which the quality of a secondary school system is recognized.

This effort has been supported by various sectors of the economy. Enterprises are usually willing to offer different forms of assistance including funds, mentors, programs, equipment, and facilities. This is an excellent investment for the future development of our society and especially for gifted pupils, who are very interested in these programs.

Conclusion

The introduction of research, innovation, and project work in schools is of great importance for the professional and personal development of pupils and teachers and the entire system of education and training. It is giving them full opportunity to meet their creative needs and desires in accordance with their personal dispositions.

The fact that all innovative and research activities are permanently and directly comparable to foreign achievements and adaptable to a variety of interesting problems (e.g., STS issues) affirms the presumption that the introduction of elements with a high motivating value has a positive influence on the improvement of the school system and complex developments within society.

References

Aikenhead, G. S. (1990). Consequences to learning science through STS: A research perspective. Paper presented at the STS education course, British Council, Oxford University.

Alberta Ministry of Education (1990). STS science education. Alberta, CAN: Curriculum Support Branch.

Durward, W. C. (1990). Science directions 9. Toronto, CAN: John Wiley and Sons/Arnold Publishing.

Institut Jožef Stefan (1989). Raziskovalna delavnica Mestne raziskovalne skupnosti na Institutu Jožef Stefan. Ljubljana, Yugoslavia.

Kobal, E. (1989). Raziskovanje je odkrivanje novega znanja. DZS, Ljubljana.

McFadden, C. P. (1990). Science plus technology and society 9. Toronto, CAN: Harcourt Brace Jovanovich.

Mladinsko raziskovalno delo (Prispevki z okrogle mize) (1990). Ljubljana, Yugoslavia: DZS.

Nagel, W. (1987). Odkrivanje in spodbujanje nadarjenih otrok. Ljubljana, Yugoslavia: DZS.

Viglietta, L. (1990). The STS approach within science education in Italy. Paper presented at the STS Education Course, British Council, Oxford University.

Zakrajšek, S.; Šušteršič, J. (1989). Raziskovalni laboratorij (Projekt SNS). Ljubljana, Yugoslavia: Srednja naravoslovna sola.

Zakrajšek, S.; Šušteršič, J.; Lopotatić, J,; Cankar, G. (1989). Introduction of students to research work at the science secondary school. Ljubljana, Yugoslavia: International School Psychology Colloquium XII.

Complete Conference Program

SIXTH ANNUAL
TECHNOLOGICAL LITERACY CONFERENCE

NASTS

National Association for
Science, Technology
and Society

February 1-3, 1991
Sheraton Washington Hotel
Washington, DC

"BROADENING PARTICIPATION IN SCIENCE, TECHNOLOGY AND MEDICINE"

Co-Sponsored by:

Accreditation Board for Engineering and Technology
American Association for the Advancement of Science
American Federation of Teachers
American Society for Engineering Education
Association for Women in Science
Epsilon Pi Tau
Federation of Materials Societies
International Technology Education Association
National Council for the Social Studies
National Council of Teachers of English
National Education Association
National Science Teachers Association
National Women's Studies Association
North American Association for Environmental Education
Student Pugwash USA
Teachers Clearinghouse for Science & Society Education
Technology Education Division, American Vocational Association
Triangle Coalition

ORGANIZATIONAL GRANT PROVIDED BY
THE CARNEGIE CORPORATION

Special Support from:

Epsilon Pi Tau (ASME Ethics Forum)
Pharmaceutical Manufacturers Association (Health and Biomedicine Theme Program)

PRINTED ON RECYCLED PAPER

ORGANIZING COMMITTEE AND STAFF

Conference Chair:

STEPHEN CUTCLIFFE, Director, Science, Technology and Society Program, Lehigh University, Bethlehem, PA, and NASTS Vice President.

Theme Chairs:

Education and Information: **IRMA JARCHO**, Teachers Clearinghouse for Science and Society Education, New York, NY, and NASTS Board Member.

Technology , Industry, and Work: **MICHAEL DYRENFURTH**, Department of Practical Arts & Vocational-Technical Education, University of Missouri-Columbia, MO.

Health and Biomedicine: **VALERIE MIKÉ**, Clinical Professor of Biostatistics, Cornell University Medical College, New York, NY.

Environment: **LOU IOZZI**, Interim Dean, Student & Academic Affairs, Cook College, Rutgers University, NJ.

Ethics and Values: **SUSAN COZZENS**, Science and Technology Studies, Rensselaer Polytechnic Institute, Troy, NY.

Women: **JANICE KOCH**, Assistant Professor of Science Education, Hofstra University, NY.

Minorities: **ALICE MOSES**, Program Director, Instructional Materials Development, National Science Foundation, Washington, DC.

International Perspectives: **CARL MITCHAM**, Acting Director, Science, Technology and Society Program, and **LEONARD WAKS**, Science, Technology and Society Program, The Pennsylvania State University, University Park, PA.

Applied Sciences: **RUSTUM ROY**, Professor of Materials Science, The Pennsylvania State University, University Park, PA.

Proposal Review Committee:

STEPHEN CUTCLIFFE, Director, Science, Technology and Society Program, Lehigh University, Bethlehem, PA (Chair).

JANICE KOCH, Assistant Professor of Science Education, Hofstra University, NY.

ROBERT MERIDETH, NASTS Conference Manager.

WILLIAM WRAGA, National Council for the Social Sciences, Piscataway, NJ.

NASTS Staff: **RUSTUM ROY** (Corporation Chair), **EUGENE BAZAN** (Members Services Director), **ROBERT MERIDETH**, (Conference Manager), **DENNIS CHEEK** and **FRANZ FOLTZ** (Exhibits and Information Marketplace), **MELADY KEHM** (Publicity), **BETSY HELD** (Office Support), **KATHY MOIR** (Registration), and **KATHY MOURANT** (Bulletin Editor).

NASTS BOARD OF DIRECTORS

Carolyn Graham, NASTS President, and New York State Department of Education, Albany, NY.

Stephen Cutcliffe, NASTS Vice President, and Director, Science, Technology and Society Program, Lehigh University, Bethlehem, PA.

George Bugliarello, NASTS Past President, and President, Polytechnic University, Brooklyn, NY.

Robert Yager, NASTS Vice-President elect, and Professor, University of Iowa, Iowa City, IA.

Glen Aikenhead, IOSTE, University of Saskatchewan.

Susan Cozzens, Dept. of Science and Technology Studies, Rensselaer Polytechnic Institute, Troy, NY.

Paul Durbin, Professor of Philosophy, University of Delaware, Newark, DE.

Steve Goldman, STS Program, Lehigh University.

Jon Harkness, K-12 Specialist, Wausau, WI.

Mary Hunt, Co-Director, Women's Alliance for Theology, Ethics, and Ritual, Silver Spring, MD.

Robert C. Hutchins, Executive Director, Opportunity Academy Management Training, Philadelphia, PA.

Irma Jarcho, Teachers Clearinghouse for Science and Society Education, New York, NY.

James Johnson, Executive Scientist, 3M Corporation (retired), River Falls, WI.

Melvin Kranzberg, Professor Emeritus of History of Technology, Georgia Institute of Technology, Atlanta.

Alice Moses, Program Director, National Science Foundation, Washington, DC.

Julianne Prager, Community Service Executive, 3M Corporation, St. Paul, MN.

James Salmon, S. J., Treasurer, Maryland Province , Society of Jesus.

Morris Shamos, M. H. Shamos & Assoc., Bronx, NY.

ORGANIZATION

The National Association for Science, Technology and Society (NASTS) was formed in 1988 to bring together the increasing number of persons and groups actively concerned with STS. In some ways, NASTS is a federation of already existing sectors of interest: K-12 educators; post-secondary educators; policy makers; scientists and engineers; public interest activists; museum and science center staff; religion professionals; members of the print and broadcast media; and participants from the international community. NASTS's goal is to provide a forum where members of these sectors can gather and take the pro-active stance to guide science and technology as reflections of our underlying values. NASTS seeks to provide the venue for all its members to meet as equals to discuss, debate, and share concerns for socity's handling of science and technology. NASTS is organized as a 501(c)3 non-profit educational corporation. Its president and 15-member board of directors, elected by the membership, guides a staff consisting of a Corporation Chair, Members Services Director, Conference Manager, and Support Staff.

ANNUAL MEETING OF NASTS MEMBERS
Friday, February 1, 1991
Cotillion Ballroom, 8:30 p.m.

1. Welcome by President Carolyn Graham, "State of NASTS Report on Initiatives Undertaken This Year."
2. Open invitation to NASTS members to attend:
   a. Dessert Reception, Saturday, 8:45 p.m.
   b. Community Meetings, Saturday, 9:30 p.m.
   c. Committee Meetings & Breakfast, Sunday, 8:00 a.m.
   d. Planning Meeting for TLC-7, Sunday, 1:30 p.m.
3. Report by Corporation Chair Rustum Roy:
   a. Role of NASTS as a national champion for making STS visible at K-12 and university levels
   b. Financial report and requirements:
      (1). General association
      (2). Symposia and projects
4. Election results for Board Members and Vice President.
5. Committee Reports:
   a. Publications Committee
   b. Awards Committee
6. Open discussion on initiatives and projects members would like to undertake through the association for the coming year.
7. Discussion of TLC-7:
   a. Overarching theme
   b. Suggestions for main speakers
   c. Location (report from Site Committee)

ADDITIONAL NASTS EVENTS

Reception (dessert, coffee & tea):
Saturday, February 2
8:45-9:30 p.m., Virginia Room

Community Meetings:
Saturday, February 2
9:30-10:30 p.m. (see page 23 for rooms)

Committees (breakfast meetings):
Sunday, February 3
8:00-9:00 p.m. (see page 23 for rooms)

TLC-7 Planning Meeting:
Sunday, February 3
1:30-4:00 p.m., Warren Room

SPECIAL ACTIVITIES

Information Marketplace:
Friday, February 1
1:00-3:00 p.m., Maryland Room

Bookstore:
Friday-Saturday, February 1-2
8:00 a.m.-5:00 p.m., Cotillion Foyer

Exhibits:
Friday-Saturday, February 1-2
8:00 a.m.-5:00 p.m., Cotillion Foyer

Delmar Publishing
Social Issues Resources Series
International Technology Education Association
Council on International & Public Affairs
Technology Student Association
The World Game
Student Pugwash USA
Science Applications International Corporation
National Oceanic & Atmospheric Administration
PETA
Union of Concerned Scientists
Zero Population Growth
MIT Press
Cambridge Press
National Academy Press
National Council of Teachers of English

PHOTOGRAPHER AVAILABLE

During the conference, **Panoramic Visions** will be available to take photographs of individuals and groups. Please contact their representative in the exhibit area to arrange photographing a session or event of your choice and to inquire about prices for this service.

AUDIOTAPES OF SESSIONS

An audiotaping service, **Sounds True**, will make available copies of audiorecordings of selected sessions. Please contact their representative in the exhibit area to inquire about which sessions will be recorded and prices of the tapes.

SUBMISSION OF PAPERS

Presenters who would like to include a copy of their paper in the ERIC system archives may do so by depositing a copy of the paper at the registration booth in the box marked "TLC-6 Papers" or by contacting the NASTS office. An index of all such papers, and the complete text of selected papers, will be published in the *Bulletin of Science, Technology and Society*.

EDUCATION AND INFORMATION

Theme Chair: **IRMA JARCHO**, Teachers Clearinghouse for Science and Society Education, Inc., New York, NY, and NASTS Board Member.

Opening Plenary Session: **PEGGY McINTOSH, SHIRLEY MALCOM, and CHUL-SOO CHIN,** three perspectives on **"Broadening Participation in Science, Technology, and Medicine."** *See Session 1.*

Guest Lecture: **JANE BUTLER KAHLE**, Condit Professor of Science Education, Miami University in Ohio, and Author, *Double Dilemma: Women & Minorities in Science Education*, **"Excellence and Equity in Science and Education."** *See Session 6.2.*

Workshop: **JEROME C. GLENN** , Executive Director, The American Council for the United Nations University, **"Status of Global Research by the United Nations University."** *See Session 11.6.*

Workshop: **JILL SCHELDRUP**, U.S. Chamber of Commerce, Washington, DC, **"Preparing Tomorrow's Workforce: An Overview of the U.S. Chamber of Commerce Education Initiative."** *See Session 13.2.*

Workshop: **EVELYN ROMAN-LAZEN**, Operation SMART Coordinator, Girls Incorporated, New York, NY, , **"Girls and Power: A Fun, Out-of-School Science Program of Girls Incorporated that Works."** *See Session 7.1.*

Workshop: **JOHN ROEDER** (Moderator), The Calhoun School, New York City, and Teachers Clearinghouse for Science and Society Education, **"Using National Issues Forum Materials in STS Education"; ALFRED MUSACCHIO** , Brooklyn Magnet School, **"How Do STS Experiences Stimulate Motivation in the Middle School Student?"** and **JANE ABBOTT** , Former President, National Association of Biology Teachers, Surfside Beach, SC, **"Students in Action on the Environmental Front"** *See Session 5.5.*

Workshop: **MICHAEL PASSOW** (Moderator), White Plains Public Schools, NY, and American Meteorologica Society; **DOUG BROWN**, Chief of Educational Services, NOAA/NESDIS; **LARRY BILBROUGH,** Educational Program Officer, Educational Affairs Division, NASA; and **ANDREW VERDON**, Director of Education, American Geological Institute, **"Children, the Earth, and STS Education: Earth Science in the K-12 Curriculum."** *See Session 11.4. See also related program on "Applied Sciences" and Sessions 12.4, 15.3, and 19.8.*

See also these related sessions: *2.2, 2.3, 2.5, 2.6, 2.7, 2.9, 2.12, 2.15, 4.1, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.13, 4.16, 4.19, 5.8, 6.3, 7.3, 7.5, 7.8, 7.9, 7.10, 7.11, 7.13, 7.14, 7.15, 7.17, 9.2, 9.3, 9.4, 9.6, 9.7, 9.8, 9.9, 9.10, 9.11, 11.10, 12.6, 13.4, 13.8, 13.9, 13.10, 13.11, 13.12, 13.14, 13.15, 15.4, 15.5, 15.7, 15.8, 15.10, 15.11, 15.12, 15.14, 15.16, 16.2, 16.3, 16.4, 16.6, 16.7, 16.8, 16.9, 16.10, 16.12, 16.13, 18.2, 18.3, 19.5 19.6, 19.8, 20.1, 20.3, 20.4, 20.6, 20.7, 20.8, 20.10, 20.12, 20.13, 21..*

ETHICS AND VALUES

Theme Chair: **SUSAN COZZENS,** Department of Science and Technology Studies, Rensselaer Polytechnic Institute, Troy, NY, and NASTS Board Member.

Plenary Session: **ELISE BOULDING** , Professor Emerita of Dartmouth College and Senior Fellow in the Dickey Endowment; Secretary-General, International Peace Research Association, Boulder, CO; Author, *Building a Global Civic Culture: Education for an Interdependent World*:, **"Imagining a World Without War."** *See Session 14.*

Guest Lecture: **JOHN M. STAUDENMAIER,** S.J., Associate Professor of History of Technology, University of Detroit, MI; Author, *Technology's Storytellers: Reweaving the Human Fabric*, **"Inclusion and Exclusion in Technological Decision Making: Who Gets a Say?"** *See Session 12.2.*

Workshop: "Ethics and Values in STS." **LEONARD WAKS** (Organizer and Moderator), Science, Technology and Society Program, The Pennsylvania State University, "Integrating Ethics Education and STS: Challenges and Opportunities"; **ROBERT FULLINWIDER,** Fellow, Kennedy Center Program on Ethics snd the Professions, Harvard University and Senior Research Scholar, Maryland Institute for Philosophy and Public Policy, "Roles and Limits of State-Supported Schools and Colleges in Values Education"; **TONY WAGNER,** Founding Director, and **SUSAN ALEXANDER,** Executive Director, Educators for Social Responsibility, "The Contributions of Non-Governmental Organizations to Ethics and Values Education Related to Science and Technology Issues"; **MICHAEL PRITCHARD,** Director, Center for the Study of Ethics and the Professions, Western Michigan University, "Critical Thinking and Philosophy for Children as Resources for STS Education"; **REGINALD FLEMING,** Associate Professor of Curriculum and Instruction, University of Saskatchewan, "Adolescent Reasoning About Socio-Technical Issues: the Educational Implications." *See Session 15.1.*

Workshop: "Race, Class, and the Environment: Ethical and Moral Issues." **ROBERT D. BULLARD** (Organizer), Associate Professor of Sociology, University of California-Riverside, and **BEVERLY H. WRIGHT** (Moderator), Wake Forest University, "The Environmental Justice Movement and the Promise of Networking." **DORCETA A. TAYLOR,** Doctorate Student, Yale University, "Translating Environmental Concern into Action among Ethnic Minorities." **BUNYAN BRYANT,** Professor, and **PAUL MOHAI,** Assistant Professor, School of Natural Resources, University of Michigan, "Environmental Inequities and the Inner City." *See Session 11.2.*

Workshop: "What's Wrong with Scientific Fraud?" **MARCEL LAFOLLETTE** (Moderator), School of International Policy Studies, George Washington University, Washington, DC; **GREG SEMON,** Staff Director and Counsel, Subcommittee on Investigations and Oversights, Committee on Science, Space and Technology, U.S. House of Representatives, Washington, DC; and **DARYL CHUBIN,** Senior Analyst, Office of Technology Assessment, U.S. Congress, Washington, DC. *See Session 5.3.*

See also these related sessions: *2.4, 4.3, 5.1, 6.1, 7.6, 11.3, 11.8, 15.15, 16.5, 18.4, 18.5, 19.4, 19.7, and the ASME Ethics Forum (page 7).*

HEALTH AND BIOMEDICINE

Theme Chair : **VALERIE MIKÉ**, Clinical Professor of Biostatistics, Cornell University Medical College, New York, NY.

Plenary Session: **ANDREW T. WEIL**, University of Arizona College of Medicine, Author, *Health and Healing: Understanding Contemporary and Alternative Medicine*, and *Natural Health, Natural Medicine: A Comprehensive Manual for Wellness and Self-Care*, **"Medicine After the Paradigm Shift,"** and **VALERIE MIKÉ** (Responder), Cornell University Medical College. *See Session 17.*

Special Guest Lecture: **EDMUND D. PELLEGRINO**, Director, Center for the Advanced Study of Ethics, Georgetown University, Author, *Humanism and the Physician*, Founding Editor, *Journal of Medicine and Philosophy*, **"Character and Virtue in the Professions."** *See Session 6.1.*

Symposium: "The Community Health Decisions Movement: Bioethics at the Grassroots." **BRUCE JENNINGS** (Organizer/Moderator), The Hastings Center, Briarcliff Manor, NY, "The Democratic Turn of Bioethics." **ANDREW BURNESS,** Burness Communications, Inc., Bethesda ,MD, "Strategies and Rationales for Public Understanding of Science." **PATRICK HILL**, Concern for Dying, New York, NY, "Community Values and Health Care Decisions" **FRANK FISCHER,** Rutgers University, Newark, NJ, "Beyond Technocratic Discourse: Risk Assessment in a Democratic Society." *See Session 5.1.*

Symposium: "Perinatal Medicine: A Microcosm of Problems Facing Society." **VALERIE MIKÉ** (Organizer/Moderator), Cornell University Medical College, New York, NY. **ALFRED N. KRAUSS, VALERIE MIKÉ, AND GAIL S. ROSS,** Cornell University Medical College, New York, NY, "Perinatal Technology: Answers and Questions." **MARIAN GRAY SECUNDY,** Howard University, Washington, DC, and University of Chicago, IL, "Perinatal Issues and Social Implications." **WARREN T. REICH**, Georgetown University School of Medicine, Washington, DC, "Caring for Perinatal Individuals: Ethical Issues." *See Session 11.3.*

Symposium: "Human Genome Research: Ethical and Social Implications." **ERIC T. JUENGST** (Organizer/Moderator), National Center for Human Genome Research, National Institutes of Health, Bethesda, MD. **ABBY LIPPMAN**, McGill University, Montreal, Canada, "The `Geneticization' of Health and Illness: Implications for Social Practice." **HELEN BEQUART HOLMES,** Hartford College for Women, Hartford, CT, "Sequencing the Human Genome: A Feminist Assessment." **JUDE PAYNE,** Health Insurance Association of America, Washington, DC, "Genetic Testing and Health Insurance: Prospects and Problems." *See Session 19.4.*

See also these related sessions: *4.3, 7.12, 9.1, 13.3, 16.5, 18.4.*

TECHNOLOGY, INDUSTRY AND WORK

Theme Chair: **MICHAEL DYRENFURTH**, Department of Practical Arts and Vocational-Technical Education, University of Missouri-Columbia.

Plenary Session: **KENNETH DICKINSON** and **WILLIAM STEVENSON**, Co-Directors, United Automobile Workers-Ford National Education Development and Training Center, **"Technological Human Resource Development: Labor and Industry Perspectives."** *See Session 8.*

Guest Lecture: **DIETRICH BLANDOW** , Chancellor, Paedagogische Hochschule-Dr. Theodor Neubauer, Erfurt, Germany (formerly G.D.R.), **"Technology: The View from Inside the Eastern Bloc."** *See Session 12.1.*

Symposium: **"Technology Education: Perspectives from Industry."** **BRIAN SWANSON,** Educational Affairs Officer, British Petroleum Company, London, England, "The Role of Industry in Technology Education." **MICHAEL RILEY,** Human Resources Assistant, 3M Corporation, Menonomie, WI, "Concepts in the Real World." *See Session 11.1.*

Symposium: **MICHAEL DYRENFURTH**, University of Missouri-Columbia, **"Key Competencies Central to Technological Literacy."** *See Session 19.1.*

Symposium: **HENRYK SZYDLOWSKI**, Adama Mickiewicz University, Poznan, Poland, **"Eastern European Approaches to Education About Work and Technology."** *See Session 20.15.*

Workshop:s **"Designing `Process-Based' Assessment Materials in Technology," and "Diagnosing `Process-Based' Capability in Technology."** **RICHARD KIMBELL,** Director, Assessment of Performance Unit, London University-Goldsmiths College, England. *See Sessions 5.6 and 6.5.*

See also these related sessions: *4.15, 4.18, 7.13, 7.17, 9.12, 9.14, 9.17, 11.8, 13.2, 15.17, 20.11.*

ENVIRONMENT

Theme Chair: **LOU IOZZI**, Interim Dean, Student & Academic Affairs, Cook College, Rutgers University, New Brunswick, NJ.

Plenary Session: **LYNN MARGULIS** (Speaker), Distinguished Professor of Botany, University of Massachusetts, Author, *Early Life*, Co-author, *Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth*, and Co-editor, *Global Ecology: Towards a Science of the Biosphere*, **"Gaia and Garbage."** *See Session 10.*

Symposium: **LOU IOZZI** (Speaker), Cook College, Rutgers University, and **ROBERT BONJA,** Supervisor of Science Education, East Brunswick Schools, NJ, **"Science, Technology, and Society: Preparing for Tomorrow's World, Decisions for Today."** *See Session 11.9.*

Symposium: **DAULAT HUSAIN**, Center for Math, Science, and Computer Education, Rutgers University, and **CAROL STRATTMAN**, Graduate School of Education, Rutgers University, **"The Rutgers-Merck Leadership Institute."** *See Session 19.2.*

See also these related sessions: *2.1, 2.9, 2.15, 4.1, 4.6, 4.7, 5.7, 7.4, 7.11, 9.7, 9.11, 9.15, 9.17, 11.2, 13.5, 13.9, 13.10, 15.8, 15.12, 16.6, 16.9, 16.13, 18.1, 20.4, 20.6, 20.8, 20.10, 20.12.*

SPECIAL SYMPOSIA

"WOMEN IN SCIENCE, TECHNOLOGY AND MEDICINE"

Organized by: **JANICE KOCH, Assistant Professor of Science** Education, Hofstra University, NY.

Plenary Session: **PEGGY McINTOSH,** Associate Director, Center for Research on Women, Wellesley College, Co-founder, Rocky Mountain Women's Institute, **"Interactive Phases of Personal and Curricular Re-Vision: Making Science Interesting."** *See Session 1.*

Workshop: **ELAINE BERNARD**, Director, Harvard University Trade Union Program, Cambridge, MA, **"Women Changing Technology Changing Women."** *See Session 13.1.*

Workshop: **RACHELLE BEAUCHAMP**, Women Innovators Project, Waterloo, Ontario, **"Mothers and Daughters of Invention."** *See Session 16.1.*

Tutorial: **JANICE KOCH**, Hofstra University, NY, **"Women Networking In Science and Technology."** Meet **STEPHANIE BIRD**, President, Association for Women in Science, Washington, DC. *See Session 12.5.*

Workshop: **JO SANDERS**, Women's Action Alliance, New York, NY, **"Equity Issues in Computer Education."** *See Session 6.7.*

Symposium: **BERNICE SANDLER**, Director, Project on the Status and Education of Woman, Association of American Colleges and Universities, Washington, DC, and **SUSAN ROSSER**, Director, Women's Studies, University of South Carolina, **"Girls, Women, Science and Technology: The K-12 Pipeline and Beyond."** *See Session 5.2.*

Symposium: **MARI HADDOX,** University of Texas Medical School, Houston, Moderator, **"Feminist Imperatives for Science and Technology,"** A symposium sponsored by the Science and Technology Task Force of the National Women's Studies Association. *See Session 15.2.*

Symposium: **SHARON KINGSLAND** (Moderator), **STUART LESLIE,** and **REBECCA LOWEN,** Department of History of Science, Johns Hopkins University, Baltimore, MD, and **DOROTHEE COCHS,** Department of American Civilization, Brown University, Providence, RI, **"Teaching Gender and Science from a Historical Perspective,"** A symposium sponsored by the History of Science Society. *See Session 11.5.*

See also these related sessions: *2.10, 2.11, 2.13, 4.2, 4.17, 4.18, 4.19, 7.1, 7.2, 7.12, 9.5, 11.3, 16.14, 18.1, 20.2, 20.5.*

"MINORITIES IN SCIENCE, TECHNOLOGY AND MEDICINE"

Organized by : **ALICE MOSES**, Program Director, Instructional Materials Development, National Science Foundation, Washington, DC.

Special Plenary Speaker: The Reverend **JESSE JACKSON,** Washington, DC, **"Increasing Minority Involvement in Science and Technology: PUSH II."** *See Session 3.*

Plenary Session; **SHIRLEY MALCOM,** Head, Directorate for Education and Human Resources Programs, American Association for the Advancement of Science, Washington, DC, **"Transforming Education to Broaden the Participation of Minorities in Science, Technology, and Medicine."** *See Session 1.*

Guest Speaker: **NORBERT S. HILL, JR.**, Executive Director, American Indian Science and Engineering Society, Boulder, CO, **"The American Indian: The Forgotten American."** *See Session 6.4.*

Workshop: **BESSIE C. HOWARD,** Author, **LARRY HAWKINS**, Director of Special Programs, University of Chicago, **"Learning to Persist, Persisting to Learn."** *See Session 5.4.*

Workshop: **RONALD BLACKBURN**, QEM Network, **"Restructuring to Improve Education for Minorities."** *See Session 11.7.*

Symposium: **DEANNA BANKS BEANNE**, Consultant in Education, "Say Yes to a Youngster's Future," a National Urban Coalition Program; **CONSTANCE TATE**, Science Education Consultant and **TREOPIA WASHINGTON**, Program Associate, American Association for the Advancement of Science, and **MARY JOHNSON,** Washington, DC, Public Schools, **"Minority Programs that Work and Why They Work."** *See Session 19.3.*

See also these related sessions: *4.12, 7.7, 13.3, 16.11, 19.5, , 20.2, 20.5.*

"INTERNATIONAL PERSPECTIVES ON SCIENCE, TECHNOLOGY, AND MEDICINE"

Organized by: **CARL MITCHAM** and **LEONARD WAKS**, Science, Technology, and Society Program, Pennsylvania State University

Plenary Session: **CHUL-SOO CHIN**, Executive Editor, International Media Institute, Seoul, Korea, **"International Perspectives on Science, Technology, and Medicine: The Case of the Korean Community Worldwide."** *See Session 1.*

Guest Lecture: **RAMON C. BARQUIN,** Executive Vice President, The Washington Consulting Group, Washington, DC, **" Computers and Ethics: The International Dimensions."** *See Session 6.6.*

See also these related sessions: *2.8, 5.7, 11.6, 12.1, 13.15, 18.8, 19.8, 20.9.*

"A REPORT ON THE NEW LIBERAL ARTS"

Friday, February 1, 1991
3:45-6:00 p.m., Marshall Room

Organized by: **JOHN TRUXAL,** Professor and Project Co-Director, Department of Technology and Society, SUNY - Stony Brook, NY.

Speakers: **MARIAN VISICH, JR..** (Moderator), Associate Dean of Engineering and Applied Sciences, SUNY - Stony Brook, NY. **SAMUEL GOLDBERG,** Program Officer, Alfred P. Sloan Foundation, NY, *"Teaching Quantitative Reasoning."* **JOHN TRUXAL,** Professor and Project Co-Director, Department of Technology and Society, SUNY - Stony Brook, NY, *"Teaching Technology."*

"TECHNOLOGICAL LITERACY VIA THE APPLIED SCIENCES"

JOINING TECHNOLOGY EDUCATION TO TRADITIONAL SCIENCE

Sponsored by the Federation of Materials Societies and the American Geological Institute.

Organized by: **RUSTUM ROY**, Professor of Materials Science, and former Director, Science, Technology, and Society Program, The Pennsylvania State University, University Park, PA.

Plenary Speaker: **BASSAM SHAKHASHIRI**, Professor of Chemistry, University of Wisconsin-Madison, and former Assistant Director for Science and Engineering Education, National Science Foundation, **"Innovations and Improvements in Science for the Non-Scientist."** *See Session 21.*

Panel: **"Applied Sciences: A New and Better Way to Introduce Mainstream Americans to Science and Technology." RUSTUM ROY** (Moderator), Professor of Materials Sciences, Pennsylvania State University, University Park, PA; **GEORGE DIETER**, Dean, College of Engineering, University of Maryland, College Park, MD; **E-AN ZEN**, Vice President, Geological Society of America. Washington, DC; and **JOHN CAHIR**, Associate Dean, College of Earth and Mineral Sciences, Pennsylvania State University, University Park, PA. *See Session 12.4.*

Panel: **"Children, the Earth, and STS Education: Earth Science in the K-12 Curriculum."** See description of session under "Education and Information Theme." *Session 11.4.*

Panel: **"The Role of Professional Societies in Getting Applied Sciences into the Curriculum." CAROL HOUK** (Moderator), ASM Foundation for Education and Research; **A. R. PALMER**, Coordinator of Educational Programs, Geological Society of America; **CHARLES C. GROAT**, Executive Director, American Geological Institute; **JOHN BOYNTON**, Education Program, Society of Automotive Engineers; **R. THOMAS WRIGHT**, Board Member, International Technology Education Association; and, **NORMAN HOCHGRAF**, Council for Chemical Research and Exxon Chemical (ret.). *See Session 15.3.*

Panel: **"Materials Science in the K-12 Curriculum." GARY MILLER** (Moderator), Director of Materials Liaison Program, Lehigh University, Bethlehem, PA; **IRENE D. HAYS**, Manager, Science Education Center, Battelle Pacific NW Laboratories, Richland, WA; **RONALD LATANAISON**, Department of Material Science, Massachusetts Institute of Technology, Cambridge, MA; and **JIM JACOBS**, Department of Technology, Norfolk State University, Norfolk, VA. *See Session 19.8.*

See also these related sessions: *2.12, 4.19, 9.2, 9.4, 9.6, 9.9, 13.13, 16.10, 18.2.*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
in conjunction with NASTS presents:

"AN ETHICS FORUM: A SCENARIO APPROACH"

Saturday, February 2, 1991
Two Sessions: 9:00 a.m.- Noon and 1:00 - 4:00 p.m.
Calvert Room
Kate Ingle, ASME Ethics Forum Chair

Format: Scenarios will be presented to a group of panelists by a moderator for discussion on the ethical conflicts involved in each scenario and the ways to resolve the dilemma posed.

The scenarios to be presented include: Ethics and the New Chemicals; A Matter of Choice (Hiring Decisions); At What Price Safety?; To Be or Not To Be? (A Whistleblower); How Close is Close Enough?; When Should a Technical Expert Get Involved?; and, Ethics and the International Marketplace.

The scenario discussions will focus on: Legal implications; Safety and risk assessment; Whose rights are being violated?; When to seek professional support?; Limits to professional responsibility; Limits to professional liability; Conflicts due to economic restraints; and, Conflicts due to race and gender differences.

A moderator will lead each lively scenario discussion with the following types of panelists lending their expertise to the forum: Professor of ethics, Corporate ethics officer, Vice-president of engineering, Attorney for an engineering firm, Senior design engineer, Consulting engineer, Environmental specialist, EPA representative, Physician, and Medical researcher.

PRE-CONFERENCE SESSIONS: Thursday, 7:00-9:00 p.m.

Pre-Conference 1: STS for K-12 Teachers: Goals, Methods, and Materials of STS Education. Arlington Room

Facilitator: **Irma Jarcho**, Teachers Clearinghouse for Science and Society Education, New York, NY, and TLC-6 Theme Chair for Education and Information Sessions.

Pre-Conference 2: STS for College and University Faculty: Goals, Methods and Materials of STS Education. Richmond Room

Facilitator: **Leonard Waks**, Science, Technology and Society Program, The Pennsylvania State University, PA, and TLC-6 Theme Co-Chair for Sessions on International Perspectives.

Pre-Conference 3: Moderator Training Workshop. Alexandria Room

This is a workshop for all conference moderators. It will deal with creating a more informal environment for the presentations to help foster discussion and interaction with all participants.

Facilitator: **Janice Koch**, Assistant Professor of Science Education, Hofstra University, NY, and TLC-6 Theme Chair for Sessions on Women.

Session 1: Opening Plenary
Friday, 8:30-10:30 a.m.

1. Opening Plenary: Broadening Participation in Science, Technology and Medicine. *Cotillion Ballroom.*

8:30-8:45 **Stephen Cutcliffe,** Conference Chair and Vice-President, NASTS, and **Carolyn Graham,** President, NASTS, *"Conference Opening and Welcome."*

8:45-9:20: **Peggy McIntosh,** Associate Director, Center for Research on Women, Wellesley College, MA, and Founder and Co-Director, National SEED Project on Inclusive Curriculum, *"Interactive Phases of Personal and Curricular Re-Vision: Making Science Interesting."* Introduced by: **Janice Koch,** TLC-6 Theme Chair for Sessions on Women.

9:20-9:55 **Shirley Malcom,** Head, Directorate for Education and Human Resources Programs, American Association for the Advancement of Science, Washington, DC, *"Transforming Education to Broaden the Participation of Minorities in Science and Technology."* Introduced by: **Alice Moses,** TLC-6 Theme Chair for Sessions on Minorities.

9:55-10:30: **Chul-Soo Chin,** Executive Editor, International Media Institute, Seoul, Korea, *"International Perspectives on Science, Technology, and Medicine: The Case of the Korean Community Worldwide."* Introduced by **Carl Mitcham** and **Leonard Waks,** TLC-6 Theme Chairs for Sessions on International Perspectives.

Session 2: Papers and Workshops
Friday, 10:45-11:45 a.m.

2.1. Population Education: Hands-on Activities for Earth's Sake. Holmes Room ENVIRONMENT

Discover innovative, hands-on techniques to introduce students in grades K-12 to issues of population growth and the related environmental impacts. Free materials!

10:45-11:45: **Pamela B. Wasserman,** Zero Population Growth, Inc., Washington, DC.

2.2. In-Service Training for Elementary and Secondary School Teachers. Marshall Room EDUCATION

10:45-11:15: **Jack Rhoton, East Tennessee State University,** Johnson City, TN, *"An Inservice Model for Training Teachers and Principals for Leadership Roles in the Improvement of Science, Technology and Society Education."*

11:15-11:45: **John Thompsen,** Penns Valley High School, Spring Mills, PA and **Bruce E. Knox,** The Pennsylvania State University, University Park, PA, *"Materials Research Lab Summer Science Teacher Internship Program."*

2.3. Teaching Science, Technology and Society in the Middle School. Wisconsin Room EDUCATION

10:45-11:05: **Stephen Fleury, Roger Hinrichs,** and **Carlton Salvagin,** SUNY, College at Oswego, NY, *"A True Interdisciplinary Approach to STS."*

11:05-11:25: **Willis J. Horak,** University of Arizona, Tucson, AZ, *"Middle School Curriculum Development Stressing STS Concepts."*

11:25-11:45: **Aline M. Stomfay-Stitz,** Nicholls State University, Thibodaux, LA, *"Language Arts and Lasers as Links to High Tech Awareness: Students and Teachers Learning Toghether."*

Moderator: **Arthur Lebofsky,** Triangle Coalition, Washington, DC.

2.4. EROSTAR: An Ecumenical Roundtable on Science, Technology and Religion. Calvert Room ETHICS

A report on efforts within three denominations (Lutheran, Presbyterian, and United Church of Christ) to establish ongoing attention to developments in science and technology as they bear on religious thought and practice, the literacy of religious professionals, and responsible participation in public policy discussions.

10:45-11:45: **James B. Miller** (Moderator), United Campus Ministry, Pittsburgh, PA; **Verlyn Barker,** United Church Board for Homeland Ministries, New York, NY; and **John Mangum,** Evangelical Lutheran Church of America, Henryville, PA.

2.5. The Evolution of a School System Moving to STS and Beyond. Woodley Room EDUCATION

Last year you heard how Creston moved into STS as a district. Come and see what has transpired – even we were surprised! Panel discussion.

10:45-11:45: **Robert Yager** (Moderator), University of Iowa, Iowa City, IA; **Curt Jeffryes, Chuck Ellers,** and **Cyndy Jeffryes,** Creston Community Schools, Creston, IA; and **Larry Kimble,** Mt. Ayr Schools, Mt. Ayr, IA.

2.6. Science and Technology: Investigating Human Dimensions. Vermont Room EDUCATION

The BSCS staff will engage you in hands-on activities and lively discussion from our middle school and technology program currently under development. Find out how to implement the middle school philosophy using a science and technology curriculum.

10:45-11:45: **Janet Carlson Powell,** Biological Sciences Study Curriculum, Colorado Springs, CO.

2.7. Images and Conceptions of Science and Scientists. Kennedy Room EDUCATION

10:45-11:15: **Dorothy B. Rosenthal,** California State University, Long Beach, CA, *"Images of Scientists: A Comparison of Science and Liberal Studies Majors."*

11:15-11:45: **Uri Zoller,** Haifa University-Oranim, Israel, *"Students' vs. Teachers' Conception of Science, Technology and Scientists in the Modern Social Context."*

Moderator: **William F. Williams,** The Pennsylvania State University, PA.

2.8. International Examples of Science and Technology Education. Roosevelt Room INTERNATIONAL

10:45-11:05: **Yoshisuke Kumano,** University of Iowa, Iowa City, IA, *"Why Does Japan Need an STS Approach in Science Education?"*

11:05-11:25: **Marguerite Gravez,** The Pennsylvania State University-Allentown Campus, PA, *"The Influence of a Society's Values on the K-12 Curriculum with Special Emphasis on Mathematics in the United States and France."*

11:25-11:45: **David K. Addae** and **David L. Licktelg,** University of Arkansas at Pine Bluff, AR, *"International Representation in Science, Technology and Medicine."*

Moderator: **Carl Mitcham,** The Pennsylvania State University, PA.

2.9. Environmental Issues and STS in the Secondary Classroom. Eisenhower Room ENVIRONMENT EDUCATION

An examination of environmental issues through the case study method will be investigated to demonstrate how science process skills can be promoted effectively.

10:45-11:45: **Ronald Truex,** New Jersey Science Teachers Association, Oakhurst, NJ.

2.10. Girls, Women and Science. Truman Room WOMEN

10:45-11:05: **Susan Zamzow,** Clarion University of Pennsylvania, Clarion, PA, *"Encouraging Girls to Consider Careers in Science and Technology."*

11:05-11:25: **N. E. Hartfree,** Falmouth, Cornwall, England, *"Women in Science and Technology: Is It Science and Technology vs. Society?"*

11:25-11:45: **John M. Wilkes** and **Tamara Payne,** Worcester Polytechnic Institute, Worcester, MA, *"A Cognitive Perspective on the Experience of Women in Science and Engineering: or Shadow Variables that Can Complicate Relations Across the Gender Line."*

Moderator: **Irma Jarcho,** NASTS Board Member, New York, NY.

2.11. Women and Inventions. Johnson Room WOMEN

10:45-11:15: **Fred M. Amram,** University of Minnesota, Minneapolis, MN, *"From Ironing to Transplants: Women as Inventors."*

11:15-11:45: **Sandra Brick** (Moderator), Science Museum of Minnesota, Minneapolis, MN, *"Dolls As Inventor Role Models."*

2.12. Hands-on Electronics for Grades 7-12 with an STS Twist. Taft Room APPLIED SCIENCES EDUCATION

A simple electronics device and related hands-on experiments allow students to discover important concepts in electronic science as well as associated technological and societal issues.

10:45-11:45: **Michael Jaeger,** Eastern Oregon State College, La Grande, OR.

2.13. Upcoming Conferences Related to STS. Ethan Allen Room

10:45-11:15: **Russel C. Jones,** University of Delaware, Newark, DE, *"Rationale for a Technological Literacy Conference: Spring 1991."*

11:15-11:45: **Patricia S. Hill,** Millersville University, Millersville, PA, *"Encouraging Young Women to Pursue Math and Science Careers: An Annual Women in Mathematics and Science Conference."*

2.14. Art and Engineering. Thomas Paine Room

A slide-illustrated presentation/workshop considering the interplay between art and engineering from ancient bas-reliefs through current structures.

10:45-11:45: **J. Paul Hartman,** University of Central Florida, Orlando, FL.

2.15. Urban and Global Environmental Curricula for Grades 5-12. Embassy Room ENVIRONMENT EDUCATION

Hands-on activities from the "Living Lightly in the City" and "Living Lightly on the Planet" series, which helps children of all ages bridge the gap between the world of nature and their own urban-centered environment.

10:45-11:45: **Gretchen Pearson,** Schlitz Audubon Center, Milwaukee, WI.

Session 3: Special Plenary Session
Friday, 12:00-1:00 p.m.

3. Special Plenary Session. *Cotillion Ballroom.*

Speaker: **The Reverend Jesse Jackson,** Washington, DC., *"Increasing Minority Involvement in Science and Technology: PUSH II."*

Introduced by: **Rustum Roy,** Corporate Chair, NASTS.

Information Marketplace
Friday, 1:00-3:00 p.m.

Information Marketplace. Maryland Room

Exhibits of materials from educational, governmental, corporate and non-governmental non-profit organizations.

Session 4: Papers/ Workshops/ Posters Friday, 1:15-2:15 p.m.

4.1. Race to Save the Planet: A New Resource for Discussing the Benefits and Detriments of Technology to the Environment. Wilmington Room ENVIRONMENT EDUCATION

This session is an opportunity to hear how educators and community organizations raise environmental issues with a new television series, as well as to view some of the video.

1:15-2:15: **Lin Foa,** Annenberg/CPB Project, Washington, DC, and **Edward C. Wolf,** Environmental Consultant, Washington, DC.

4.2. Women in Engineering. Holmes Room WOMEN

1:15-1:35: **Jennifer L. Croissant,** Rensselaer Polytechnic Institute, Troy, NY, *"Women in Engineering: Why Us and Why Now?"*

1:35-1:55: **Rhea Jezer,** Congressional Fellow (Syracuse University), Washington, DC, *"Does Congress Encourage Women to Study Science and Math?"*

1:55-2:15: **Sharon Jadrnack Luck,** The Pennsylvania State University, University Park, PA, *"Women in Engineering Programs: Universities Respond to the Underrepresentation of Women in Engineering."*

4.3. The Ethics of Health Care. Marshall Room ETHICS & BIOMEDICINE

1:15-1:35: **Janet F. Cogliano,** Towson State University, Towson, MD, *"Politics, Patients, and Professionals: The Bioethics/Technology Web."*

1:35-1:55: **T. Patrick Hill,** Concern for Dying, New York, NY, *"The Impact of Technology on Medical Care at the End of Life."*

1:55-2:15: **John C. Moskop,** East Carolina University School of Medicine, Greenville, NC, *"The Ethics of High Tech Home Care."*

Moderator: **Valerie Miké,** Cornell University Medical College, NY.

4.4. Technological Literacy: Clarification of Concept. Nathan Hale Room EDUCATION

Education about technological literacy must include: the impact and challenge of technological literacy; various perspectives such as labor and government; and, international comparisons. Panel presentation.

1:15-2:15: **Michael R. Kozak** (Moderator), University of North Texas, Denton, TX; **Ronald D. Todd,** Drexel University, Philadelphia, PA; **Jule D. Scarborough,** Northern Illinois University, DeKalb, IL; **James L. Barnes,** Eastern Michigan University, Ypsilanti, MI; and **Tom Erekson,** University of Maryland, College Park, MD.

4.5. Science & Technology in Literature. Kennedy Room

1:15-1:45: **Dennis Rohatyn and Mitchell Malachowski,** University of San Diego, CA, *"Teaching Scientific Classics."*

1:45-2:15: **Brian T. Garvey,** Neptune, NJ, *"Technology, Society and Literature: An Education Module."*

4.6. A Successful Model Using Interdisciplinary Teacher Teams to Create Site-Specific Curriculum Materials. Calvert Room EDUCATION

Learn how teams of science, technology, and social studies teachers developed interdisciplinary curricula at a one-week summer institute and how these curricula were used.

1:15-2:15: **Arthur Lebofsky** (Moderator), Triangle Coalition for Science and Technology Education, Washington, DC; **John Roeder,** The Calhoun School, New York, NY; **John White,** West Islip High School, West Islip, NY; and **Harold Woods,** Pomona Junior High School, Suffern, NY.

4.7. The Diaper Dilemma: What is Better for Society? What is Better for the Planet Earth? Can Science Help Society Decide? Woodley Room ENVIRONMENT EDUCATION

Through cooperative learning and future problem solving techniques, this workshop examines an STS issue using a common household product: diapers.

1:15-2:15: **Beverly Nelson,** Hunterdon Central Regional High School, Flemington, NJ.

4.8. Teaching STS Concepts through Interdisciplinary Courses and Programs. Vermont Room EDUCATION

1:15-1:35: **Richard S. Demaree, Jr.,** and **Ron Hirschbein,** California State University, Chico, CA, *"Mutually Assured Instruction: Team-Teaching an Interdisciplinary Course Entitled 'Science & Human Values'."*

1:35-1:55: **Morton E. Winston,** Trenton State College, Trenton, NJ, *"Society, Ethics, and Technology: An Interdisciplinary Core General Education Course."*

1:55-2:15: **Nasrine Adibe,** C. W. Post Campus, Long Island University, Brookville, NY, *"Conceptual Model for Integrating Technology in the Three Basic Disciplines."*

Moderator: **Richard Deitrich,** The Pennsylvania State University, PA.

4.9. Examples of STS in the Classroom. Roosevelt Room

1:15-1:35: **Ann H. Stoddard,** University of North Florida, Jacksonville, FL, *"The Use of Science and Technology in Social Education."*

1:35-1:55: **Mark Reagan** and **Rick Hogan,** Worcester Polytechnic Institute, Worcester, MA, *"Response to an S-STS Curriculum: A Study of ChemCom."*

1:55-2:15: **Armel Boutard,** University of Quebec at Montreal, Canada, and **Lucie Suave,** Consultant, Richelieu, Quebec, Canada, *"Physics for All: Innovations through STS.E Education."*

4.10. Changing the Focus: The Transition to STS as a Curriculum Organizer in Established Educational Schemes. Eisenhower Room EDUCATION

This session is designed for those interested in STS education. Discussion will center on the changes in roles and expectations which should occur in teachers, students, administrators, and parents in support of the introduction of STS programs in schools.

1:15-2:15: **William McComas** (Moderator), **Susan Blunck,** and **Julia McArthur,** University of Iowa, Iowa City, IA; and **Mark Brockmeyer,** Iowa City High School, IA.

4.11. Linking Teachers and Students in an Urban Aerospace Program. Truman Room EDUCATION

Using Learning Link, PBS's computer bulletin, and the Young Astronauts, we connect students and teachers in New York to share research on a Moonbase project.

1:15-2:15: **Ellen Goldstein,** New York City Public Schools, NY.

4.12. Programs to Attract Minority Students to Science, Math, and Engineering. Johnson Room MINORITIES

1:15-1:35: **Timothy D. Champion,** J. C. Smith University, Charlotte, NC, *"Why Science? STS as an Answer to the Need for Science Majors."*

1:35-1:55: **Judith W. Rosenthal,** Kean College of New Jersey, Union, NJ, *"Attracting Hispanic (Latino) Students into the Sciences, Mathematics, and Engineering -- Successful Strategies in New Jersey."*

1:55-2:15: **Eric R. Hamilton,** Loyola University of Chicago, IL, *"Development and Implementation of an NSF-Funded Comprehensive Regional Center for Minorities."*

4.13. Workshop on a Science, Technology, and Society Course. Taft Room EDUCATION

This is a workshop discussing an STS course with core units: nature of science, nature of technology, humans in the environment, current issues in science, and projects, experiments, and case studies.

1:15-2:15: **Eknath V. Marathé,** Lincoln County Board of Education, St. Catherines, Ontario, Canada.

4.14. Teaching Architectural Design Representation through Critical Thinking. Thomas Paine Room

This presentation engages the audience to think about architectural design representation as the result of critical thinking about communication. A case study is presented of a first-year design representation class at Bowling Green State University.

1:15-2:15: **Frank M. Bosworth** and **Paul A. Tanner,** Bowling Green State University, Bowling Green, OH.

4.15. Models for Cognitive Mapping Using Recent Developments in Neurophysiology. Ethan Allen Room INDUSTRY

Recent developments in neurophysiology have an impact on the way we generate computer-based expert systems and neural networks. This presentation ties together cognitive learning theory with these recent medical advances, creating a new paradigm.

1:15-2:15: **J. S. Boyce,** University of Maryland, College Park, MD.

4.16. Emerging Themes in Science and Technology Education. Embassy Room EDUCATION

1:15-1:35: **Clifford N. Matthews,** University of Illinois at Chicago, IL, *"Universal Evolution: A Unifying Theme in Science Education."*

1:35-1:55: **P. S. di Virgilio,** University of Toronto, Canada, *"Learning Skills for Machine and Man--The Insuperable Brain--Interdisciplinary Educational Goals in the 21st Century."*

(continued)

4.16. *(continued):*

1:55-2:15: **Randall G. Nichols,** University of Cincinnati, OH, *"Overcoming Dangerous Educational Technology?"*

Moderator: **William F. Willams,** The Pennsylvania State University, PA.

4.17. Women's Studies and STS. Wisconsin Room WOMEN

1:15-1:35: **Barbara Belgun Kaplan,** University of Marlyand, College Park, MD, *"STS, Women's Studies, and the Transformation of the Undergraduate Curriculum."*

1:35-1:55: **L Joan Lorch** and **Elizabeth B. Conant,** Canisius College, Buffalo, NY, *"The Biology of Women: Bridging Women's Studies and Science for Non-Majors."*

1:55-2:15: **Zuleyma Tang Halpin,** University of Missouri-St. Louis, MO, *"Women in Science: Demanding a Bigger Piece of the Pie or a New Recipe?"*

4.18. Psychosocial Aspects of Shiftwork and the Double Burden of the Woman Shiftworker. Kansas Room INDUSTRY WOMEN

Around-the-clock shiftwork, including rotating, permanent, irregular, and flextime work, poses various biological, psychological and social effects on workers. Members of this panel will outline the issues involved as they relate primarily to the psychosocial factors, from the personal to the national and international.

1:15-2:15: **Frederick M. Brown** (Moderator), The Pennsylvania State University, University Park, PA; **Harriet Presser,** University of Maryland, College Park, MD; **Frida Marina Fischer,** University of Sao Paulo, Brazil; **Don Tepas,** University of Connecticut, Storrs, CT; and **David Liskowsky,** Office of Technology Assessment, Washington, DC.

4.19. Poster Presentations. *Maryland Room.*

Posters will be on display from 1:00-3:00p.m. Presenters will be available from 1:15-2:15 p.m.

Patsy Ann Giese, Slippery Rock University, Butler, PA, *"Optimizing the Learning of Female Students in Science and Mathematics."*

Mary Lewis Sivertsen, U. S. Department of Education, Washington, DC, *"Science Improvement through the National Diffusion Network."*

Jane Berndt McGinnis, George Washington University, Washington, DC, *"Simple Science: Activities with Everyday Materials."*

Session 5: Invited Presentations Friday, 2:30-3:30 p.m.

5.1. The Community Health Decisions Movement: Bioethics at the Grassroots. Wilmington Room BIOMEDICINE ETHICS

Bruce Jennings (Organizer and Moderator), The Hastings Center, Briarcliff Manor, NY, *"The Democratic Turn of Bioethics."* **Andrew Burness,** Burness Communications, Inc.,Bethesda, MD,*"Strategies and Rationales for Public Understanding of Science."* **Patrick Hill,** Concern for Dying, New York, NY, *"Community Values and Health Care Decisions."* **Frank Fischer,** Rutgers University, Newark, NJ, *"Beyond Technocratic Discourse: Risk Assessment in a Democratic Society."*

Session 5: Invited Presentations
Friday, 2:30-3:30 p.m.

5.2. Girls, Women, Science, and Technology: The K-12 Pipeline and Beyond. Holmes Room WOMEN

Bernice Sandler, Director, Project on the Status and Education of Women, Association of American Colleges and Universities, Washington, DC, and **Susan Rosser**, Director, Women's Studies, University of South Carolina. *Introduced by:* **Janice Koch**, Hofstra University, NY.

5.3. What's Wrong with Scientific Fraud? Marshall Room ETHICS

Marcel LaFollette (Organizer and Moderator), School of International Policy Studies, George Washington University, Washington, DC; **Greg Semon**, Staff Director and Counsel, Subcommittee on Investigations and Oversights, Committee on Science, Space and Technology, U.S. House of Representatives, Washington, DC; and **Daryl Chubin**, Senior Analyst, Office of Technology Assessment, U.S. Congress, Washington, DC.

5.4. Learning to Persist; Persisting to Learn. Woodley Room MINORITIES

Bessie Howard, Washington, DC, Public School System, and **Larry Hawkins**, Director of Special Programs, University of Chicago, IL.

5.5. Teachers Talk to Teachers. Kansas Room EDUCATION

John Roeder (Organizer and Moderator), The Calhoun School, New York, NY and Teachers Clearinghouse for Science and Society Education, NY, *"Using National Issues Forum Materials in STS Education."* **Alfred Musacchio**, Brooklyn Magnet School, NY, *"How Do STS Experiences Stimulate Motivation in the Middle School Student?"* **Jane Abbott**, former President, National Association of Biology Teachers, Surfside Beach, SC, *"Students in Action on the Environmental Front."*

5.6. Designing 'Process-Based' Assessment Materials in Technology. Wisconsin Room (See also Session 6.5) INDUSTRY

Richard Kimbell, Director, Assessment of Performance Unit, London University-Goldsmiths College, England. *Introduced by:* **Rodney Custer**, University of Missouri-Columbia, MO.

5.7. Passing the Buck: Corporate Social Responsibility, Technical Expertise, and the Political Dynamics of the Hazardous Waste Issue. Vermont Room ENVIRONMENT

Denis Smith, Unit for Risk and Crisis Management, Leicester Business School, Leicester, UK.

5.8. STS and Peace Studies: Common Ground. Calvert Room EDUCATION

Andrew Murray, Director, The Baker Institute for Peace and Conflict Studies, Juniata College, Huntingdon, PA, and President, The Peace Studies Association.

5.9. The Role of Alliances in STS. Nathan Hale Room

Panel will provide varied perspectives on the role alliances have in supporting the development and implementation of STS at the local level. The advantages and opportunities for involving the private sector in curriculum change, developing broad support for educational reform, and in providing education in the broadest sense, will be presented. The resources and roles of the Triangle Coalition will be reviewed.

2:30-3:30: **Robert K. James** (Moderator), Texas A & M University, College Station, TX; **Jane Konrad**, University of Pittsburgh, PA; **E. Peter Benzing**, Morbay Corporation, Sewickley, PA; and **Indira Nair**, Carnegie Mellon University, Pittsburgh, PA.

Session 6: Guest Lectures
Friday, 3:45-4:45 p.m.

6.1. Character and Virtue in the Professions. Wilmington Room BIOMEDICINE ETHICS

Speaker: **Edmund D. Pellegrino**, Director, Center for the Advanced Study of Ethics, Georgetown University, Washington, DC, Author, *Humanism and the Physician*, Founding Editor, *Journal of Medicine and Philosophy*.

Introduced by: **Valerie Miké**, Cornell University Medical College, New York, NY, and TLC-6 Theme Chair for Health and Biomedicine Sessions.

6.2. Excellence and Equity in Science and Education. Kansas Room EDUCATION

Speaker: **Jane Butler Kahle**, Condit Professor of Science Education, Miami University, OH, and Author, *Double Dilemma: Women and Minorities in Science Education*.

Introduced by: **Jane Abbott**, Surfside Beach, SC.

6.3. A Report on the New Liberal Arts. Marshall Room (Extended session 3:45-6:00)

Speakers: **Marian Visich, Jr.** (Moderator), Associate Dean of Engineering and Applied Sciences, SUNY - Stony Brook, NY. **Samuel Goldberg**, Program Officer, Alfred P. Sloan Foundation, *"Teaching Quantitative Reasoning."* **John Truxal**, Professor and Project Co-director, Department of Technology and Society, SUNY - Stony Brook, NY, *"Teaching Technology."*

6.4. The American Indian: The Forgotten American. Holmes Room MINORITIES

Speaker: **Norbert S. Hill, Jr.**, Executive Director, American Indian Science and Engineering Society, Boulder, CO.

Introduced by: **Alice Moses**, National Science Foundation.

6.5. Diagnosing 'Process-Based' Capability in Technology. Wisconsin Room (Continuation of Session 5.6) INDUSTRY

Speaker: **Richard Kimbell**, Director, Assessment of Performance Unit, London University - Goldsmiths College, England.

437

6.6. Computers and Ethics: The International Dimensions. Calvert Room INTERNATIONAL

Speaker: **Ramon C. Barquin,** Executive Vice President, The Washington Consulting Group, Washington, DC.

Introduced by: **Carl Mitcham,** The Pennsylvania State University, PA.

6.7. Equity Issues in Computer Education. Nathan Hale Room WOMEN

Jo Sanders, Women's Action Alliance, New York, NY. *Introduced by:* **Janice Koch,** Hofstra University, NY.

Session 7: Papers and Workshops Friday, 5:00-6:00 p.m.

7.1. Invited Presentation: Girls and Power: A Fun Out-of-School Science Program of Girls Incorporated that Works. Holmes Room EDUCATION

5:00-6:00: **Evelyn Roman-Lazen,** Operation SMART Coordinator, Girls Incorporated, New York, NY. Introduced by: **Irma Jarcho,** Teachers Clearinghouse for Science & Society Education, NY.

7.2. Women and Technology. Wilmington Room WOMEN

5:00-5:20: **Margaret Honey** and **Cornelia Brunner,** Bank Street College of Education, New York, NY, *"The 'Good-enough' Dilemma: Exploring Issues of Professional Competence Among Women Technological Experts."*

5:20-5:40: **Suzanne K. Damarin,** The Ohio State University, Columbus, OH, *"Education, Technology, and Educational Technology: A Gender Perspective."*

5:40-6:00: **Cornelia Brunner** and **Margaret Honey,** Bank Street College of Education, New York, NY, *"Gender and Technological Desire."*

7.3. New Technology as Aids to Teaching Science and Technology. Nathan Hale Room EDUCATION

5:00-5:20: **E. Barbara Klemm,** University of Hawaii, Honolulu, HI, *"Technology in the Hawaii Marine Science Studies Curriculum."*

5:20-5:40: **Mary DeWall** and **Frank Watt Ireton,** National Science Teachers Association, Washington, DC, *"The JASON Curriculum Project."*

5:40-6:00: **Daniel J. Brovey,** Queens College, Flushing, NY, *"Enhancing College Science Teaching: An Interactive Technology Project."*

Moderator: **Ellen Goldstein,** New York City Public Schools.

7.4. Trash for the Long Haul. Kansas Room ENVIRONMENT

Trash for the Long Haul is a recycling curriculum designed to help teachers incorporate solid waste/recycling concepts and issues into their classroom. Teachers can involve students actively in real life problems and teach them critical thinking skills using this action oriented process.

5:00-6:00: **Magdalena Donaldson,** Missouri Energy Resources Project, St. Louis, MO.

7.5. The New York Science, Technology and Society Education Project. [illegible] EDUCATION

Materials currently under development will be displayed and discussed. The project is a cooperative partnership between the New York State Education Department, The New York Power Pool, and the Atmospheric Sciences Research Center of SUNY.

5:00-6:00: **Dennis W. Cheek** (Moderator) and **William T. Peruzzi,** New York State Education Department, Albany, NY.

7.6. Ethics and STS Issues. Wisconsin Room ETHICS

5:00-5:30: **Eric Katz,** New Jersey Institute of Technology, Newark, NJ, *"Teaching Environmental Ethics: An Introductory Module."*

5:30-6:00: **Vincent di Norcia,** University of Sudbury, Ontario, Canada, *"Ethics and Controlling New Technologies."*

7.7. Attracting Minority Scholars to Ethics and Values Studies in Science and Technology. Woodley Room MINORITIES

Roundtable discussion on broadening the ethics and values studies agenda in order to understand better the content of various minority perspectives and the influence these perspectives have on value preferences and decisions regarding science and technology.

5:00-6:00: **Amy Crumpton** and **Mark S. Frankel,** American Association for the Advancement of Science, Washington, DC.

7.8. STS Programs for the Public: What Science Museums Have Learned. Vermont Room EDUCATION

Formal and informal evaluation of science museum programs and exhibits provides insights into some successful strategies for exploring issues with the general public.

5:00-6:00: **Roree Iris-Williams** and **Ann Mintz,** Franklin Institute Science Museums, Philadelphia, PA.

7.9. Technical Writing and Documentation. Kennedy Room

5:00-5:30: **Vincent Casaregola,** University of Wisconsin-Oshkosh, WI, *"Technical Documentation and Technical Discourse: A Tale of Two Processes."*

5:30-6:00: **Jennie Dautermann,** Miami University, Oxford, OH, *"When Nurses Write for Nurses: Producing Technical Manuals in an Everyday Workplace Setting."*

7.10. Teaching Issue-Oriented Science Using Chemical Education for Public Understanding (CEPUP) Modules. Roosevelt Room EDUCATION

Participate in activities designed to teach science in a real world context, now being developed at the Lawrence Hall of Science, University of California-Berkeley. Present and future modules featured.

5:00-6:00: **Robert E. Horvat,** Buffalo State College, Buffalo, NY.

BEST COPY AVAILABLE

Session 7: Friday, 5:00-6:00 p.m.
(continued from previous page)

7.11. Environmental Technology: Filling the Nation's Needs. Eisenhower Room ENVIRONMENT EDUCATION

Starting and operating a vocational environmental technology program in the public high school.

5:00-6:00: **H. Silcox, Roger L. Meyer, and John Kennedy**, Abraham Lincoln High School, Philadelphia, PA.

7.12. Women and Health. Truman Room BIOMEDICINE WOMEN

5:00-5:30: **Adrianne Bendich**, Hoffmann-La Roche, Inc., Nutley, NJ, *"The Importance of Perinatal Nutrition Status as a Predictor of Pregnancy Outcomes."*

5:30-6:00: **Sharon D. McCoy**, Emory University, Atlanta, GA, *"Women and Anger / Epilepsy and Malpractice: Toward Seeking Alternative Therapies for Chronic Illness."*

7.13. School-Industry Cooperation: Cement Chemistry. Johnson Room INDUSTRY EDUCATION

Increase chemistry relevance for students by relating instruction and experiments to modified industrial procedures that make use of regional resources and computer applications.

5:00-6:00: **Michael W. T. Olive** (Moderator), Westminster High School, Frederick, MD; **John L. Lynam,** North Carroll High School, Hampstead, MD; **Barbara Burns,** Liberty High School, Sykesville, MD; and **Robert L. Foor-Hogue,** South Carroll High School, Millers, MD.

7.14. How Kids Make the World. Taft Room EDUCATION

The child's environment includes many examples of technology. Come investigate ways to identify and integrate technology in the active learning environment of your classroom. The workshop will include several hands-on experiences.

5:00-6:00: **Nancy Moore,** Educational Consultant, and **Verna Lister,** Toronto School System,Toronto, Canada.

7.15. STS at Work Across the Disciplines at the High School Level. Ethan Allen Room EDUCATION

Presentation of the results of a two-year NSF project which brought together high school teachers from four disciplines in an STS approach to American society.

5:00-6:00: **Edward Jay Pershey,** Tsongas Industrial History Center, Lowell, MA, **Roger Simon,** Lehigh University, Bethlehem, PA; and **Michael Hughes,** Metheun High School, Metheun, MA.

7.16. Technological Literacy as Technologies of Self. Embassy Rm

A student-led roundtable will focus on the problem of how technology can reinforce, modify, or threaten our moral and practical knowledge of ourselves. Specific technologies will be highlighted.

5:00-6:00: **Alexander E. Hooke** (Organizer), **Chris Engel, Annette Preat, Laura Talbott,** and **Naomi Willey,** Villa Julie College, Stevenson, MD.

7.17. Technology and Industry Educational Programs. Thomas Paine Room INDUSTRY EDUCATION

5:00-5:20: **Richard Deitrich,** The Pennsylvania State University, University Park, PA, *"A Model for Technological Literacy for Education and Industry."*

5:20-5:40: **Jim Burnett,** Olney Central College, Olney, IL, *"Semiconductor Technology Operator Program: SemiTOP."*

5:40-6:00: **Armel Boutard,** University of Quebec at Montreal, Canada, and **Chantale Boutin,** Centre de Formation en Environnement, Sainte-Scholastique, Quebec, Canada, *"STS.E Education as Applied to Management of Industrial and Municipal Environments."*

Moderator: **Richard Deitrich,** The Pennsylvania State University, PA.

Session 8: Plenary
Friday, 7:30-8:30 p.m.

8. Technological Human Resource Development: Labor and Industry Perspectives. *Cotillion Ballroom.*

Speakers: **Kenneth Dickinson** and **William Stevenson,** Co-Directors, United Auto Workers-Ford National Education Development and Training Center.

Introduced by : **Michael Dyrenfurth,** University of Missouri-Columbia, and Theme Chair for TLC-6 Technology, Industry and Work Sessions.

NASTS Business Meeting
Friday, 8:30-10:00p.m.

NASTS Business Meeting. Cotillion Ballroom OPEN TO ALL TLC-6 PARTICIPANTS

8:30-10:00: **See page 3** for a listing of the agenda and items of business.

Session 9: Papers and Workshops
Saturday, 8:00-8:45 a.m.

9.1. Design and Implementation of an 'STS' Core Curriculum in the Health Professions. Alexandria Room BIOMEDICINE

This session will focus on three topics: a goal-directed approach in developing an interdisciplinary STS core curriculum; instructional strategies for teaching professional valuing and decision making in STS courses; and, implications of a study on assessing ethical sensitivity among health professionals.

8:00-8:45: **Robin A. Harvan,** University of Medicine & Dentistry of New Jersey, Newark, NJ.

9.2. Consumer Science for the Non-science Student. Warren Room EDUCATION

To motivate the disinterested student, try a course in consumer science with hands-on lab experiments that explore the nature of everyday items. Topics include analyzing food nutrients, detergents, cosmetics, and textiles.

8:00-8:45: **Florence G. Korchin**, Middlesex County College, Red Bank, NJ.

9.3. The Jason Project: An Interdisciplinary Approach to Learning. Holmes Room EDUCATION

Project Jason seeks to improve science attitudes of teachers and students in grades 4-12 through "telepresence," the use of telecommunications technology to create a simulated presence at a remote site and through an inderdisciplinary curriculum.

8:00-8:45: **Judith A. Bazler**, Lehigh University, Bethlehem, PA.

9.4. Using Music, Computers, Lasers, and Synthesizers to Teach Science. Marshall Room APPLIED SCIENCES

An introduction to computer music; science and technology of a new art.

8:00-8:45: **Victor A. Stanionis** and **Hugh Berberich**, Iona College, New Rochelle, NY.

9.5. Images and Art Forms of Technology. Kansas Room

8:00-8:20: **Julie Wosk**, SUNY - Maritime College, Throggs Neck Station, NY, *"Mastering the Machine: Images of Women and Technology in Twentieth-Century Advertising and Art."*

8:20-8:40: **Eunice M. Roe**, Rutgers University, New Brunswick, NJ, *"The Grain Elevator as Industrial Art Form: Use of Photohistory to Enhance Understanding of Technological and Social Processes."*

9.6. Under Pressure! Teaching Underwater Diving Technologies in Secondary Science Classes. Woodley Room EDUCATION

Using inexpensive apparatus, participants investigate the nature of pressure in water, then apply principles of physics to understand the designs of representative historic and modern underwater diving technologies.

8:00-8:45: **E. Barbara Klemm**, University of Hawaii, Honolulu, HI.

9.7. No, STS Instruction Does Not have to Be Doom-and-Gloom. Vermont Room ENVIRONMENT EDUCATION

STS learning activities which produce identity with the past and future, and self-worth in attacking and acting on real world problems.

8:00-8:45: **Paul E. Bell**, The Pennsylvania State University, University Park, PA.

9.8. Instructional Computing: Implications for Elementary School Teachers. Kennedy Room EDUCATION

This session will demonstrate how simulation and data base programs relevant to the elementary school curriculum provide a powerful combination of cooperative learning and problem solving strategies.

8:00-8:45: **Janet Bosnick** and **Ann H. Stoddard**, University of North Florida, Jacksonville, FL.

9.9. Weather, Environmental and Geography Study Under a Mass Media Umbrella. Roosevelt Room APPLIED SCIENCES EDUCATION

Because the mass media makes weather "come alive," it provides immediate, visual, and dynamic information about the importance of weather. This session will show teachers techniques for using the mass media as a motivator for weather study.

8:00-8:45: **H. Michael Mogil** and **Barbara G. Levine**, How the Weatherworks, Inc., Rockville, MD.

9.10. Fundamental Assumptions about Science and Technology Which May Hinder STS Teaching, and Ways to Overcome Them. Eisenhower Room EDUCATION

Explores obstacles to STS teaching and learning presented by conventional understandings of science, technology, and values; offers more congenial alternatives, and suggests strategies for college STS and science teaching.

8:00-8:45: **Barbara J. Reeves**, The Ohio State University, Columbus, OH, and **Cheryl Ney**, Capital University, Columbus, OH.

9.11. Radwaste Issues in the College Classroom. Truman Room ENVIRONMENT EDUCATION

We have achieved great success at getting students and the public involved in discussing all the issues associated with radwaste isolation, from moral to scientific.

8:00-8:45: **Donald H. Williams**, Hope College, Holland, MI.

9.12. Workload Factors Associated with Proactive Environmental Management of Industrial Facilities. Johnson Room INDUSTRY

This workshop examines industrial processes and associated workload requirements as mandated by laws on hazardous materials, underground storage tanks, and air and water pollution.

8:00-8:45: **Charlotte Young**, **Amit Bando**, and **Jonathan Elias**, Argonne National Laboratory, Argonne, IL.

9.13. Engineering 2000: A Look at the Next Ten Years. Taft Room

This is a forecast of the developments in engineering in the next decade, with emphasis on mechanical engineering. It results from a project commissioned by the American Society of Mechanical Engineers, completed in June 1990.

8:00-8:45: **Joseph F. Coates** and **Jennifer Jarratt**, J. F. Coates, Inc., Washington, DC.

Session 9: Saturday 8:00-8:45 a.m. (continued from previous page)

9.14. High Technology, the State, and Global Competition. Ethan Allen Room INDUSTRY

Analysis of the relations between high technology and government support in key sectors of global competition, e.g. electronics, pharmaceuticals, transport, and chemicals.

8:00-8:45: **Aaron Segal,** University of Texas at El Paso, TX, and **Tom Owens,** National Science Foundation, Washington, DC.

9.15. Energy Planning and Conservation Strategies. Thomas Paine Room. ENVIRONMENT

8:00-8:20: **Constantine Hadjilambrinos,** University of Delaware, Newark, DE, *"Energy Planning: Certainties in an Uncertain World."*

8:20-8:40: **Insook Han, Jong-dall Kim,** and **Rebecca Wykoff,** University of Delaware, Newark, DE, *"Institutional Strategies for Energy Efficient and Environmentally Sensitive Development in Four Asian Countries."*

Moderator: **John Byrne,** University of Delaware, Newark, DE.

9.16. STS Studies: Dealing with Opposition. Embassy Room.

How do we deal with opposition to STS studies? Why does it exist? What are the sources of opposition? What can we do?

8:00-8:45: **Jim Steele,** James Madison University, Harrisonburg, VA; **Paul Jablon**, Brooklyn College, NY; **Gary Benenson,** City College of New York; and **John Truxal**, SUNY - Stony Brook, NY.

9.17. Nuclear Energy's Response to Society's Needs. Calvert Room ENVIRONMENT INDUSTRY

Panel will discuss the effect of public opinion and political pressures on nuclear power plant design, construction, and operation.

8:00-8:45: **Carl Patrick** (Moderator), Director of Nuclear Policy and Information, New York Power Authority, White Plains, NY; **Robert Livingston,** Manager, Editorial Programs, U.S. Council for Energy

Session 10: Plenary Saturday, 9:00-10:00 a.m.

10. Gala and Garbage. *Cotillion Ballroom.*

Speaker: **Lynn Margulis,** Distinguished Professor of Botany, University of Massachusetts; Author, *Early Life;* Co-author, *Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth;* and Co-editor, *Global Ecology: Towards a Science of the Biosphere.*

Introduced by: **Lou Iozzi,** Rutgers University, New Brunswick, NJ, and TLC-6 Theme Chair for Environment Sessions.

Session 11: Invited Presentations Saturday, 10:15-11:15 a.m.

11.1. Technology Education: Perspectives from Industry. Alexandria Room INDUSTRY

10:15-10:45: **Brian Swanson,** Educational Affairs Officer, British Petroleum Company, London, England, *"The Role of Industry in Technology Education."*

10:45-11:15: **Michael Riley,** Human Resources Assistant, 3M Corporation, Menomonie, WI, *"Concepts in the Real World."*

Moderator: **Michael Dyrenfurth,** University of Missouri-Columbia, MO.

11.2. Race, Class, and the Environment: Ethical and Moral Issues. Warren Room ETHICS ENVIRONMENT

10:15-11:15: **Beverly H. Wright (Moderator),** Wake Forest University, Winston-Salem, NC. **Robert D. Bullard** (Organizer), University of California-Riverside, CA, and **Beverly H. Wright,** *"The Environmental Justice Movement and the Promise of Networking."* **Dorceta A. Taylor,** Yale University, New Haven, CT, *"Building a Movement for Environmental Justice: Understanding the Role of Race and Class in Environmental Activism."* **Bunyan Bryant** and **Paul Mohai,** University of Michigan, Ann Arbor, MI, *"Environmental Inequities and the Inner City."*

11.3. Perinatal Medicine: A Microcosm of Problems Facing Society. Holmes Room BIOMEDICINE ETHICS

10:15-11:15: **Valerie Miké** (Organizer and Moderator), Cornell University Medical College, New York, NY. **Alfred N. Krauss, Valerie Miké,** and **Gail S. Ross,** Cornell University Medical College, New York, NY, *"Perinatal Technology: Answers and Questions."* **Marian Gray Secundy,** Howard University, Washington, DC, and University of Chicago, IL, *"Perinatal Issues and Social Implications."* **Warren T. Reich,** Georgetown University School of Medicine, Washington, DC, *"Caring for Perinatal Individuals: Ethical Issues."*

11.4. Children, the Earth, and STS Education: Earth Science in the K-12 Curriculum. Marshall Room EDUCATION APPLIED SCIENCES

10:15-11:15: **Michael Passow** (Organizer and Moderator), White Plains Public Schools, NY and American Meteorological Society; **Doug Brown,** Chief of Educational Services, National Oceanographic and Atmospheric Administration - NESDIS; **Larry Bilbrough,** Educational Programs Officer, Educational Affairs Division, National Aeronautics and Space Administration ;and **Andrew Verdon,** Director of Education, American Geological Institute, Washington, DC.

11.5. Teaching Gender and Science from a Historical Perspective. *A symposium sponsored by the History of Science Society.* Kansas Room WOMEN.

10:15-11:15: **Sharon Kingsland (Moderator), Stuart Leslie** and **Rebecca Lowen,** Department of History of Science, Johns Hopkins University, Baltimore, MD; and **Dorothee Cochs,** Department of American Civilization, Brown University, Providence RI.

11.6. Status of Global Research by the United Nations University. Kennedy Room EDUCATION

10:15-11:15: **Jerome C. Glenn**, Executive Director, The American Council for the United Nations University, New York, NY. *Introduced by:* **Irma Jarcho**, NASTS Board Member, New York, NY.

11.7. Restructuring to Improve Education for Minorities. Vermont Room MINORITIES

10:15-11:15: **Ronald Blackburn**, Quality Education for Minorities (QEM) Network, Washington, DC.

11.8. Coalition for Computer Ethics Panel Discussion. Woodley Room INDUSTRY ETHICS

10:15-11:15: **John Boyles** (Moderator), Coalition for Computer Ethics; **Al Colville**, International Business Machines; **Victor Ferkiss**, Coalition for Computer Ethics; **Harry Yeide**, Chairman of Religion Department, George Washington University; and **David Trickett**, Washington Consulting Group.

11.9. Science, Technology, and Society: Preparing for Tomorrow's World, Decisions for Today. Roosevelt Room ENVIRONMENT

Louis Iozzi (Moderator), Interim Dean, Student & Academic Affairs, Cook College, Rutgers University, NJ, and **Robert Bonja**, Supervisor of Science Education, East Brunswick Schools, NJ.

11.10. STS in the Social Studies. Eisenhower Room EDUCATION

William Wraga (Moderator), Bernards Township Public Schools, Basking Ridge, NJ. **Phillip A. Heath**, The Ohio State University at Lima, OH, *"Science, Technology, and Society in the Middle Grades: Developing Instructional Units Using Local Issues and Topics."* **Sara F. Anderson**, Northern Virginia Community College, Annandale, VA, *"Beyond Infusion: Another Way to Introduce STS Content into Existing Social Studies and Science Courses."*

Session 12: Guest Lectures
Saturday, 11:30 a.m.-12:30 p.m.

12.1. Technology: The View from Inside the Eastern Bloc. Alexandria Room INDUSTRY INTERNATIONAL

Speaker: **Dietrich Blandow**, Chancellor, Paedagogische Hochschule-Dr. Theodor Neubauer, Erfurt, Germany (formerly G.D.R.).

Introduced by: **Michael Dyrenfurth**, University of Missouri-Columbia, MO.

12.2. Inclusion and Exclusion in Technological Decision Making: Who Gets a Say? Warren Room ETHICS

Speaker: **John M. Staudenmaier**, S.J., Associate Professor of History of Technology, University of Detroit, MI, and Author, *Technology's Storytellers: Reweaving the Human Fabric.*

Introduced by: **Stephen Cutcliffe**, Conference Chairman.

12.3. Defining STS: Can We Reach Consensus? Holmes Room

Speaker: **Paul T. Durbin**, Professor of Philosophy, University of Delaware, Newark, DE, and Member, NASTS Board of Directors.

Introduced by: **Leonard Waks**, Theme Co-Chair, International Sessions.

12.4. Applied Science: A New and Better Way to Introduce Mainstream Americans to Science and Technology. Marshall Room (Extended session: 11:30 a.m.-1:45 p.m.) APPLIED SCIENCES

Panel: **Rustum Roy** (Moderator), Professor of Materials Science, The Pennsylvania State University, University Park, PA; **George Dieter**, Dean, College of Engineering, University of Maryland, College Park, MD; **E-an Zen**, U.S. Geological Survey, and Adjunct Professor, University of Maryland, College Park, MD; and **John Cahir**, Associate Dean, College of Earth and Mineral Sciences, Pennsylvania State University, University Park, PA.

12.5. Women Networking in Science and Technology. Wisconsin Room WOMEN

Tutorial: **Janice Koch** (Organizer), Hofstra University, NY. *Meet:* **Stephanie Bird**, President, Association for Women in Science.

12.6. STS Education and the NSTA's Scope, Sequence and Coordination of Secondary Science Projects. Kansas Room EDUCATION

An overview of this important NSTS effort to reform secondary science education in America and how several field sites throughout the nation plan to incorporate STS education into science curriculum.

Bonnie Brunkhorst, President, and **Russell Aiuto**, Project Director, SS & CSS, National Science Teachers Association, Washington, DC, and **Robert Yager**, University of Iowa, Iowa City, IA.

Session 13: Papers and Workshops
Saturday, 12:45-1:45 p.m.

13.1. Women Changing Technology Changing Women. Invited Paper Alexandria Room WOMEN

12:45-1:45: **Elaine Bernard**, Director, Harvard University Trade Union Program, Cambridge, MA. *Introduced by:* **Janice Koch**, Hofstra University, NY.

13.2. Preparing Tomorrow's Workforce: An Overview of the U. S. Chamber of Commerce's Education Initiative. Invited Paper Warren Room EDUCATION INDUSTRY

12:45-1:45: **Jill Scheldrup**, U. S. Chamber of Commerce, Washington, DC.

Session 13: Saturday, 12:45-1:45 p.m. (continued from previous page)

13.3. Minority Recruitment and Training in the Biomedical Sciences. Holmes Room MINORITIES BIOMEDICINE

12:45-1:05: **Michael S. Gaines,** University of Kansas, Lawrence, KS, *"Minority Recruitment , Retention, and Development in the Biomedical Sciences: A Model for Research Universities."*

1:05-1:25: **Natalie Hannon, Ronald Paul,** and **Lisa Brandon Rodriguez,** Bronx Lebanon Hospital Center, NY, *"The Health Academy: A Model Project Encouraging Minority Students to Enter Health Careers."*

1:25-1:45: **John M. Kmetz, Betty W. Barber,** and **Paula Getzin**, Kean College of New Jersey, Union, NJ, *"Project Science Star and Health Epic: Two Successful Summer Programs for Minority Sutdents."*

Moderator: **Nancy Van Vranken**, Teachers Clearinghouse for Science & Society Education, New York, NY.

13.4. Case Studies in Promoting STS Education in Schools. Kansas Room EDUCATION

12:45-1:05: **Mike Robinson,** University of Nevada, Reno, NV, *"The Nevada Science Project."*

1:05-1:25: **George Skena** and **Joy Young,** Norfolk City Public Schools, Norfolk, VA, *"Innovative Knowledge Transfer Systems for Secondary Students."*

1:25-1:45: **Thom Votaw** and **Stephen Horan**, New Mexico State University, Las Cruces, NM, and **Eunice Thaeler** and **Bonnie Votaw,** Las Cruces Public Schools, NM, *"Jumping into STS: One Way that a School District and a University Jumped in Together."*

Moderator: **Richard Deitrich,** The Pennsylvania State University, PA.

13.5. The Future of American Energy Policy. Wisconsin Room ENVIRONMENT

This session will examine the factors likely to shape future American energy use. Panelists will identify the most promising technologies and best policies.

12:45-1:45: **Alden Meyer** and **Deborah Gordon**, Union of Concerned Scientists, Washington, DC.

13.6. STS and Contemporary Issues. Woodley Room

12:45-1:05: **Dennis Rohatyn**, University of San Diego, CA, *"The Challenger Challenge."*

1:05-1:25: **Carl S. Frankel,** The Pennsysvania State University - Hazleton Campus, Hazleton, PA, *"Modest Proposal: A Useful Political Role for STS."*

1:25-1:45: **Albert H. Wurth, Jr.,** Lehigh University, Bethlehem, PA, *"Public Participation in Technology: Procedure or Substance?"*

Moderator: **Irma Jarcho,** Teachers Clearinghouse for Science & Society Education, New York, NY.

13.7. The Other Economic Summit as the "Other Economic Strategies." Vermont Room

Organizers of The Other Economic Summit (TOES) will present the "other economic strategies" for international economic justice, new perspectives on ecology and economics, and democratization and regeneration of the economy.

12:45-1:45: **Trent Schroyer** (Moderator), Ramapo College, Mahwah, NJ; **Robert King,** Texas Department of Agriculture, Austin, TX; **Ward Morehouse,** Intermediate Technology Development Group, New York, NY; and **Romesh Diwan,** Rensselaer Polytechnic Institute, Troy, NY.

13.8. Science Literacy and Science Writing. Kennedy Room.

12:45-1:15: **Matthew R. Nikkari,** Wayne State University, Detroit, MI, *"Shaving with Occam's Razor: Science Literacy and Student Writing."*

1:15-1:45: **Tracy Webb,** University of Michigan, Ann Arbor, MI, *"Writing to Learn Science."*

13.9. Teaching 6-12 Grade Students to Investigate Environmental Issues. Roosevelt Room ENVIRONMENT EDUCATION

This session describes an approach to teaching youngsters the skills needed to investigate and evaluate environmental issues, and to take positive citizen actions regarding their solutions.

12:45-1:45: **Trudi L. Volk** and **Harold Hungerford,** Southern Illinois University, Carbondale, IL.

13.10. Discovering STS in Cities: Strategies for Urban Teachers and Students. Eisenhower Room EDUCATION

The environmental impacts of technology are most obvious in cities. This workshop will explore strategies for addressing urban issues at all levels of education.

12:45-1:45: **Gary Benenson** (Moderator), City College of New York, NY; **Pamela Abder-Fraser,** New York University, NY; **Paul Jablon,** Brooklyn College, NY; and, **Leonard James,** New York City Technical College, NY.

13.11. Research Internships: An Ideal Tool to Attract Youngsters to Choose Careers in Science and Technology. Truman Room EDUCATION

High school students in the NY-NJ metropolitan area carry out research projects with scientists and engineers – a successful bridge into scientific and technological careers.

12:45-1:45: **Dana Levine** (Moderator), Liberty Science Center, Jersey City, NJ; **Beatrice A. Kiler,** NY Academy of Sciences, New York, NY; **Victoria B. Leyton,** Rutgers University, Piscataway, NJ; and **Susan Fahrenholz,** ACS Project SEED, Bloomfield, NJ.

13.12. Technology-Science-Society: An Amalgamation in the DASH Project. Johnson Room EDUCATION

A hands-on workshop highlighting selected K-4 developmental approaches in science and health (DASH) project activities that develop societal awareness and science through technology.

12:45-1:45: **Francis Marion Pottenger III, Donald B. Young,** and **Carol Brennan,** University of Hawaii, Honolulu, HI.

13.13. Toying with Technology. Taft Room APPLIED SCIENCES

"Toying with Technology" is the topic of an article which appeared in *TIES Magazine* in 1989. This workshop will provide participants with hands-on experience of the activities described in that article.

12:45-1:45: **Patricia A. Hutchinson**, Editor-in-Chief, *TIES Magazine*, Philadelphia, PA.

13.14. Teaching STS with Telecommunications: Selected STS Projects on SciNet. Ethan Allen Room EDUCATION

During the current school year, SciNet is the vehicle for a number of STS projects which link students and teachers around the continent and around the world.

12:45-1:45: **Graham Orpwood** (Moderator), New York University, New York, NY; **Nancy Stefanik**, Advocacy Institute, Washington, DC; and **John Ord**, SciNet, Toronto, Canada.

13.15. A Humanities Inclusion Proposal for Engineering Education. Thomas Paine Room INTERNATIONAL EDUCATION

12:45-1:45: **Llana Torres de Forzanti**, Valencia, Carabobo, Venezuela.

13.16. Sociopolitical Issues of Science and Technology. Embassy Room

12:45-1:05: **Thomas Simon**, University of Baltimore, MD, *"Technology, Democracy and Injustice: Case Study of Teledemocracy."*

1:05-1:25: **Michael S. Ameigh**, SUNY-College at Oswego, NY, *"Public Attitudes Toward Technology: The User Interface."*

1:25-1:45: **Jennifer L. Croissant**, Rensselaer Polytechnic Institute, Troy, NY, *"Science Education and Techno-Scientific Literacy: Historical Parallels with the Progressive Movement."*

Session 14: Plenary
Saturday, 2:00-3:00 p.m.

14. Imagining a World Without War. *Cotillion Ballroom.*

Speaker: **Elise Boulding**, Professor Emerita of Dartmouth College and Senior Fellow in the Dickey Endowment; Secretary-General, International Peace Research Association, Boulder, CO; Author, *Building a Global Civic Culture: Education for an Interdependent World.*

Introduced by: **Susan Cozzens**, Rensselaer Polytechnic Institute, Troy, NY, and TLC-6 Theme Chair for Ethics and Values Sessions.

Session 15: Papers and Workshops
Saturday, 3:15-4:15 p.m.

15.1. Invited Workshop: Ethics and Values in STS. *(Extended Session 3:15-5:30.)* Woodley Room ETHICS

3:15-4:15: Panel. *4:30-5:30:* Roundtable.
Leonard J. Waks (Organizer and Moderator), Science, Technology and Society Program, The Pennsylvania State University, University Park, PA, *"Integrating Ethics Education and STS: Challenges and Opportunities."*

Robert Fullinwider, Fellow, Kennedy Center Program on Ethics and the Professions, Harvard University, and Senior Research Scholar, Maryland Institute for Philosophy and Public Policy, *"Roles and Limits of State-Supported Schools and Colleges in Values Education."*.

Tony Wagner, Founding Director, and **Susan Alexander**, Executive Director, Educators for Social Responsibility, *"The Contributions of Non-Governmental Organizations to Ethics and Values Education Related to Science and Technology Issues."*

Michael Pritchard, Director, Center for the Study of Ethics and the Professions, Western Michigan University, *"Critical Thinking and Philosophy for Children as Resources for STS Education."*

Reginald Fleming, Associate Professor of Curriculum and Instruction, University of Saskatchewan, *"Adolescent Reasoning About Socio-Technical Issues: the Educational Implications."*

15.2. Invited Paper: Feminist Imperatives for Science and Technology. *Sponsored by the Science and Technology Task Force of the National Women Studies Association* Alexandria Room WOMEN

3:15-4:15: **Mari Haddox**, University of Texas Medical School, Houston, TX. *Introduced by:* **Janice Koch**, Hofstra University, NY.

15.3 The Role of Professional Societies in Getting Applied Sciences into the Curriculum. *(Extended session: 3:15-5:30 p.m.)* Marshall Room APPLIED SCIENCES

Panel: **Carol Houk** (Moderator), Manager, Student Outreach, ASM Foundation for Education and Research,; **A. R. Palmer**, Coordinator of Educational Programs, Geological Society of America; **Charles C. Groat**, Executive Director, American Geological Institute; **John Boynton**, Education Program, Society of Automotive Engineers; **R. Thomas Wright**, Board Member, International Technology Education Association; and, **Norman Hochgraf**, Council for Chemical Research, and Exxon Chemical (ret.), "Partnerships in Science Education."

15.4. STS Network. Wisconsin Room EDUCATION

3:15-3:35: **Paul E. Bell**, The Pennsylvania State University, University Park, PA, *"Survey of the States: A Second Look at Documents Promoting STS."*

3:35-4:15: **E. Joseph Piel**, SUNY-Stony Brook, NY, and **Ron Truex**, New Jersey Science Teachers Association, Oakhurst, NJ, *"A National STS Network Success Story for New Jersey."*

Session 15: Saturday, 3:15-4:15 p.m. (continued from previous page)

15.5. Technology Education Curriculum Developments (K-12) in America's Heartland: A University's State, Regional, and National Successes. *(Extended session: 3:15-5:30 p.m.)* Kansas Room EDUCATION

An expert in implementing problem solving and three directors of successful interdisciplinary technology focused curriculum development projects share conceptual framework, industry-school partnering arrangements, implementation and adoption strategies applied to individuals, groups and institutions.

Panel: **Jerry Streichler** (Organizer and Moderator), Dean, College of Technology, **Ernest N. Savage**, Professor of Technology Education and Director of Graduate Studies, College of Technology, and **John Sinn**, Professor of Technology, and Associate Dean, College of Technology, Bowling Green State University, Bowling Green, OH; and **Anthony Gordon,** Education Inspector, Design and Technology, The Kingston Center, Staffordshire, UK (on leave at Bowling Green State University).

15.6. A Critical Perspective on STS: Part 1 - Underlying Social Forces; Part 2 - Underlying Values & Assumptions. *(Extended session: 3:15-5:30 p.m.)* Vermont Room

This session critically examines those social forces and ideological assumptions behind both technological development and STS that are typically left unquestioned in NASTS scholarship.

Panel: **Douglas D. Noble** (Organizer), University of Rochester, NY; **Philip Kraft** (Moderator), SUNY- Binghamton, NY; **Douglas Taylor,** Baltimore Public Schools, MD; **Raymond Grosshans,** National Technical Institute for the Deaf, Rochester, NY; **W. H. Vanderburg**, University of Toronto, ON; and **Gary Benenson,** City College of New York, NY.

15.7. Language as a Learning Fulcrum in Science and Humanities. Warren Room EDUCATION

Students' language is often neglected in discussions of technological literacy. Presenters will show how to use language as a "lever" for improved interdisciplinary learning.

3:15-4:15: **Stephen Tchudi** (Moderator), University of Nevada, Reno; **Judith Gilbert,** Colorado Department of Education; **Alan Purves,** State University of New York at Albany; and **Mark Waldo**, University of Nevada, Reno.

15.8. Trash: It's Piling Up! Holmes Room ENVIRONMENT EDUCATION

This solid waste management module was developed for use with middle level students as an interdisciplinary unit that is adaptable to biological as well as chemical sciences, mathematics, social studies and the arts. It is intended to involve students in the community educational process as future citizens.

3:15-4:15: **Ronni Pressman,** Middletown Junior High School, Middletown, NY; **Ellen Egan**, New Windsor, NY; and **Margaret Pelll,** Cuddebackville, NY.

15.9. Technological Literacy and Liberal Arts. Kennedy Room

3:15-3:35: **Louis Rodriquez,** Lehigh University, Bethlehem, PA, *"Technological Literacy at the Community College Level: Pedagogical Methods."*

3:35-3:55: **Joseph R. Herkert,** Lafayette College, Easton, PA, *"Establishing an Interdisciplinary Minor in Technological Studies at a Liberal Arts College."*

3:55-4:15: **Charles J. Abaté,** Onodaga Community College, Syracuse, NY, *"Rx for Liberal Arts Brain Power: A Dose of Technology, Creativity, and Problem-Solving."*

Moderator: **Richard Deitrich,** The Pennsylvania State University, PA.

15.10. STS in the Secondary School: What it Means in the Context of Earth Science, Biology, and Chemistry Courses. Roosevelt Room EDUCATION

An elaboration of STS modules in discipline-based courses in the high school. Materials and approaches will be shared. Information concerning assessment of student learning will be included.

3:15-4:15: **Robert E. Yager** (Moderator), University of Iowa, Iowa City, IA; and **Mark Brockmeyer** (Organizer), **Terence Coleman,** and **Kevin Koopnick,** City High School, Iowa City, IA.

15.11. SSIP Space Science Student Involvement Program. Eisenhower Room EDUCATION

Students of all grade levels and interests get excited by the space program. Come discover ways to use the Space Science Student Involvement Program in your classroom to generate interest in and comprehension of science concepts. Free program materials.

3:15-4:15: **Caroline Benson** and **Helenmarie Hofman**, National Science Teachers Association, Washington, DC.

15.12. Mission Patch Activity for Mission to Planet Earth. Truman Room ENVIRONMENT EDUCATION

Workshop participants develop a mission patch for a mission to planet earth after determining the prioritzation of problems to be solved.

3:15-4:15: **Bonnie Bracey,** Ashlawn Elementary School, Arlington, VA.

15.13. Technology, Values, and Visual Literacy through Architecture and Structural Engineering. Johnson Room

This illustrated presentation shows how technology and the humanities can be linked through architectural history and structural engineering.

3:15-4:15: **K. R. Stunkel,** Monmouth College, West Long Branch, NJ.

15.14. Science for Life and Living: Integrating Science, Technology and Health in Grades K-6. Taft Room EDUCATION

Experience activities that exemplify the technology concepts presented in Science for Life and Living. This innovative new curriculum was funded by NSF and developed by BSCS.

3:15-4:15: **Terry Switzer** and **Rodger Bybee,** BSCS, Colorado Springs, CO.

15.15. Ethics in the Lab and Classroom. Ethan Allen Room ETHICS

3:15-3:35: **Linda M. Sweeting,** Towson State University, Baltimore, MD, *"Everyday Ethics in Undergraduate Laboratories."*

3:35-3:55: **R. Eugene Mellican,** University of Lowell, MA, *"From Fusion Frenzy to Fraud: Reflections on Science and Its Cultural Norms."*

3:55-4:15: **Newton D. Gregg,** University of Central Florida-Brevard Campus, Cocoa, FL, *"Ethics in the Teaching Profession."*

Moderator: **Jane Abbott,** Surfside Beach, SC.

15.16: Sports and STS for Middle Level Science Classes. Thomas Paine Room EDUCATION

This workshop provides hands-on experiences and information on how to present an STS unit to middle level science classes using sports as a "hook."

3:15-4:15: **Jane Cappiello,** Science Teachers Association of New York State, Delmar, NY, and **Joanne K. Gallagher,** Science Teachers Association of New York State, Melrose, NY.

15.17. Applying Communication Technology Concepts. Embassy Room INDUSTRY

Participants will utilize an optical link to illustrate the concepts of the communication technology model. Discussion will include laser demonstrations.

3:15-4:15: **Emerson Wiens,** Illinois State University, Norman, IL.

Session 16: Papers and Workshops Saturday, 4:30-5:30 p.m.

16.1. Invited Paper: Mothers and Daughters of Invention. Alexandria Room WOMEN

4:30-5:30: **Rachelle Beauchamp, Women Innovators Project, Waterloo,** Ontario, Canada. *Introduced by:* **Janice Koch,** Hofstra University, NY.

16.2. Illinois Mathematics and Science Academy Pilot for "Science, Society and the Future": Global Implications for Systemic Change. Wisconsin Room EDUCATION

Session explores a laboratory model for the development and implementation of a statewide action agenda to restructure mathematics, science, and technology education, K-12, across constituencies.

4:30-5:30: **Richard B. Bryant, Jr.** (Moderator), **William Stepien, David Workman, Terri Willard, Dinah Simmen,** Illinois Mathematics and Science Academy, Aurora, IL.

16.3. Pre-Service Teacher Education Programs. Warren Room EDUCATION

4:30-4:50: **Paul E. Bell and John R. McClure, The Pennsylvania State** University, University Park, PA, *"Effects of Prerequisite Courses and STS Methods Instruction on Preservice Science Teachers' Cognitive Structures."*

4:50-5:10: **James D. Lubbers,** Grand Valley State University, Allendale, MI, *"PRISE: Total Immersion for Learning Science."*

5:20-5:30: **Cheryl L. Ney,** Capital University , Columbus, OH, *"Connecting Courses: STS and Methods Seminars."*

16.4. Edith Bowen's Elementary STS- Unified Studies Program: A Blueprint for Success. Holmes Room EDUCATION

This presentation will share and demonstrate how this innovative STS program is getting rave reviews from teachers, students, and parents. Organizational handouts and materials will be provided.

4:30-5:30: **Prent Klag** and **Steve Archibald,** Utah State University, Logan, UT.

16.5. Killing as Healing: The Nazi Doctor. Calvert Room ETHICS BIOMEDICINE

What ethical dilemmas and psychological mechanisms characterized the highly trained Nazi medical doctor in the transformation from healer to killer during the Holocaust?

4:30-5:30: **David Phoebus** and **George McCeney,** Dulaney High School, Timonium, MD.

16.6. Ecology, Technology, and Literature: Insights for Educators. Kennedy Room EDUCATION ENVIRONMENT

Literary treatments -- from two hemispheres and two centuries -- of ecological, social, cultural, and philosophical problems which technology has caused and may help solve.

4:30-5:30: **Carl Wood** (Organizer and Moderator), Principia College, Elsah, IL. **Theodore Blake,** University of Kansas, Lawrence, KS, *"The One Thing Needful": Dickens' Environmental Paradigm in Hard Times."* **Elisabeth A. Ebert,** Independent Scholar, Reston, VA, *"The Ethics of Earth: Rawlings' and Van Der Post's System of Natural Morality."* **Carl Wood,** Principia College, Elsah, IL, *"Demon or Angel? -- Western Technology in the African Environment."*

16.7. The Illinois Rivers Project: An Integrated High School Curriculum Strand. Roosevelt Room EDUCATION

A project involving science, social studies, English, and computers in 47 high schools along the Mississippi River. River quality is studied through science kits, shared through computer bulletin boards, and written about in a publication called 'Meanderings.'

4:30-5:30: **Robert Williams,** Southern Illinois University, Edwardsville, IL, and **Marylin Lisowski,** Eastern Illinois University, Charleston, IL.

Session 16: Saturday 4:30-5:30 p.m. (continued from previous page)

16.8. Cognitive Styles, Learning Styles and the Response to S-STS and M-STS Curricula. Eisenhower Room EDUCATION

This session will be a brainstorming session on the implications of the pattern of findings emerging in the Worcester area studies of the reception of S-STS type curricula.

4:30-5:30: **John M. Wilkes** and **Keith McCormick,** Worcester Polytechnic Institute, Worcester, MA.

16.9. Energy and Environmental Issues. Truman Room ENVIRONMENT

4:30-4:50: **Jesse S. Tatum,** Michigan Technological University, Houghton, MI, *"Assuming We Know What People Want: Possible Lessons from the Home Power Movement."*

4:50-5:10: **Steven M. Hoffman,** University of St. Thomas, St. Paul, MN; **John Byrne,** University of Delaware, Newark, DE; and **Cecilia R. Martinez,** Inner Grove Heights, MN, *"The Political Economy of Energy, Environment and Development."*

5:10-5:30: **Gladius Lewis,** Memphis State University, TN, *"Electric Utility Plants and Acid Rain: Policy Aspects of Emissions Control."*

Moderator: **John Roeder,** The Calhoun School, NY.

16.10. Science and the Liberal Arts Curriculum. Johnson Room

4:30-4:50: **Fred H. Bowers,** Spelman College, Atlanta, GA, and **James G. Wingate,** Central Piedmont Community College, Charlotte, NC, *"The Forecasting and Scheduling of Personnel in the Credit Authorization Department of a Major Credit Card Company: A 'New Liberal Arts' Program"*

4:50-5:10: **Louis B. Rosenblatt,** The Park School, Brooklandville, MD, *"Fire: From Prometheus to Thermodynamics."*

5:10-5:50: **Martin L. Sage,** Syracuse University, NY, *"Introducing New Liberal Arts Ideas into the Curriculum."*

16.11. Race and Gender Issues with Science and Technology. Taft Room MINORITIES WOMEN

4:30-5:00: **Eloy Rodriguez** and **Frances Chavez,** University of California-Irvine, CA, *"Howard Hughes Center for Research and Academic Excellence: A Pipeline Model Approach in Science Education."*

5:10-5:30: **Paula M. Getzin** and **Richard Kroll,** Kean College, Union, NJ, *"Fostering Awareness of Science and Technology Issues through a Science and Technology Course – Differences by Ethnicity, Age and Gender."*

16.12. NEWMAST NEWEST: Super Space Science NASA Education Workshops for Math, Science, and Technology Teachers. Thomas Paine Room EDUCATION

Attend this session and discover the NASA Education Workshops for Math, Science, and Technology teachers. Free materials will be distributed as you learn more about the experience of being a NEWMAST/NEWEST participant.

4:30-5:30: **Gracie Beck** and **Helenmarie Hofman,** National Science Teachers Association, College Park, MD.

16.13. Communicating Environmental Risk at the High School/College Level: An STS Simulation Approach. Embassy Room ENVIRONMENT EDUCATION

Participants will receive complete lesson plans and instructions for four simulations, one dealing specifically with environmental risk, the others having risk as a significant element. Attendees may participate in one of the simulations.

4:30-5:30: **James P. Hamilton,** The Pennsylvania State University-Mont Alto Campus, PA.

16.14. Interpreting Technological Objects: Looking through a Gendered Lens. Ethan Allen Room WOMEN

This workshop will explore the ways in which gender plays a role in our understanding of technological objects and will discuss findings from two research studies that explore this issue with adults and adolescents.

4:30-5:30: **Margaret Honey** and **Babette Moeller,** Bank Street College of Education, New York, NY; and, **Dorothy Bennett,** Children's Television Workshop, New York, NY.

Session 17: Plenary Saturday, 5:45-6:45 p.m.

17. Medicine After the Paradigm Shift. *Cotillion Ballroom.*

Speaker: **Andrew T. Weil,** University of Arizona College of Medicine, Author, *Health and Healing: Understanding Contemporary and Alternative Medicine* and *Natural Health, Natural Medicine: A Comprehensive Manual for Wellness and Self-Care.*

Introduction and Response by: **Valerie Miké,** Cornell University Medical College, New York, NY, and TLC-6 Theme Chair for Health and Biomedicine Sessions.

NASTS Dessert Reception Saturday, 8:45-9:30 p.m.

NASTS Reception: **"Coffee, Tea, and Dessert."** Virginia Room. OPEN TO ALL CONFERENCE PARTICIPANTS.

NASTS Community Meetings
Saturday, 9:30-10:30 p.m.

Community Meetings: **Discussion groups for professional communities.** OPEN TO ALL CONFERENCE PARTICIPANTS.

Elementary/Middle School. Holmes Room.

Middle/High School. Kansas Room.

College and University. Wisconsin Room.

Museums, Science Centers, Media. Calvert Room.

Scientists/Engineers/Managers/Other Professionals. Woodley Room.

Graduate Students. Vermont Room.

NASTS Committees: Breakfast Meeting
Sunday, 8:00-9:00 a.m.

Committee Meetings. **Continental Breakfast served in the Woodley Room. Sunday, 8:00-9:00 a.m. for Committee participants.**

President Carolyn Graham invites you to join one of the new NASTS committees for the coming year. Inaugural meetings will take place this morning. You can help yourself to breakfast in the Woodley Room and take it to your committee meeting of choice:

NASTS Position Papers.
Woodley Room.

Regional Chapters and Conferences.
Kennedy Room.

STS Assessment and Evaluation.
Roosevelt Room.

Organizational Linkages: Pre-College Education.
Eisenhower Room.

Organizational Linkages: Science and Engineering.
Truman Room.

Organizational Linkages: International.
Johnson Room.

Community Awareness Activities.
Taft Room.

Session 18: Papers and Workshops
Sunday, 8:00-9:00 a.m.

18.1. Ecology, Feminism, and Alternative Paradigms. Dover Room WOMEN ENVIRONMENT

8:00-8:20: **James B. Miller,** United Campus Ministry, Pittsburgh, PA, *"Is Mother Nature a Child Abuser?"*

8:20-8:40: **Barbara Anne Radtke,** Emmanuel College, Boston, MA, *"Values in Ecofeminism and Creation-Centered Spirituality: The Difference They Make in Policy Making."*

8:40-9:00: **Robert E. Baker,** North Shore Community College, Beverly, MA, *"Feminist Values and the Future: A Male View."*

18.2. Issues-Oriented Science Education. Holmes Room APPLIED SCIENCES EDUCATION

8:00-8:40: **David L. Adams** and **James Philips,** Babson College, Babson Park, MA, *"Issues-Directed Science Education: Theory and Practice."*

8:40-9:00: **Lisa Ragsdale** and **Nava Ben-Zvi,** University of Maryland, College Park, MD, *"Issues in the World of Chemistry: A Video Dimension."*

18.3. Reception of Science and Math S-STS Modules Developed for Grades 4-7. Marshall Room EDUCATION

8:00-9:00: **John M. Wilkes** (Moderator), Worcester Polytechnic Institute, Worcester, MA. **Michelle Burke** and **Darcy Simpkins,** Worcester Polytechnic Institute, *"Grade 4 Module: 'The Struggle to Save Lake Quinsigamond."* **Gunnar Klevens, Tim Conway, Dave Gesner,** and **Peter Campbell,** Worcester Polytechnic Institute, *"Grade 6 Modules: 'The Lessons of Love Canal' and 'Electricity, Electrocution and Power Line.'"* **Burt LaChance,** Worcester Polytechnic Institute, *"Grade 7 Module: 'Statistics, Probability and Dead Fish: Estimating the Impact of Toxic Wastes on Aquatic Animal Life.'"*

18.4. A Critical Look at Animal Research. Kansas Room BIOMEDICINE ETHICS

This workshop will explore the scientific problems of animal research. Slides and handouts will be used to stimulate discussion and clarify the economic and health costs of our continued dependence on this research, with examples of questionable uses of animals in AIDS research.

8:00-9:00: **Betsy Todd** and **Murry Cohen,** Medical Research Modernization Committee, New York, NY.

18.5. Ethics and Engineering: A Role-Playing Workshop. Calvert Room ETHICS

Role-playing exercise and discussion of issues with respect to ethical conflicts in the design of a military aircraft wheel-braking system. (Role playing volunteers should contact moderator/presenter early at TLC-6!)

8:00-9:00: **J. Paul Hartman,** University of Central Florida, Orlando, FL, and **Allan Glanniny,** University of Virginia, Charlottesville, VA.

448

Session 18: Sunday, 8:00-9:00 a.m. (continued from previous page)

18.6. Student Pugwash and the Renaissance of Student Activism. Vermont Room

This session will provide attendees with a historical overview of Student Pugwash, inform them about several current areas of STS-related research, and give them some ideas about how to facilitate student activism on their campuses.

8:00-9:00: **Craig Waddell, Mia Wotton,** and **Scott Murto,** Michigan Technological University, Houghton, MI.

18.8. STS Around the World. Thomas Paine Room INTERNATIONAL

A panel discussion from members of the international STS community.

8:00-9:00: **Carl Mitcham** and **Leonard Waks** (Moderators), TLC-6 Theme Co-Chairs for Sessions on International Perspectives, and The Pennsylvania State University, PA; and **Eric Higgs.**

Session 19: Invited Presentations Sunday, 9:15-10:15 a.m.

19.1. Key Competencies Central to Technological Literacy. Dover Room INDUSTRY

Presents the results of three years' research into what competencies are actually involved in becoming technologically literate. Includes a model derived from the author's chapter in the Council on Technology Teacher Education 1991 Yearbook.

9:15-10:15: **Michael Dyrenfurth** (Organizer and Moderator), Department of Practical Arts & Vocational -Technical Education, University of Missouri-Columbia, MO, and TLC-6 Theme Chair for Technology, Industry, and Work Sessions; **Donald Holznagle,** Director of Technology Educational Laboratory, Portland, OR; and **Dietrich Blandow,** Erfurt, Germany.

19.2. The Rutgers-Merck Leadership Institute. Kennedy Room ENVIRONMENT

9:15-10:15: **Dualhat Husain,** Center for Math, Science, and Computer Education, Rutgers University, and **Carol Strattman,** Graduate School of Education, Rutgers University.

19.3. Minority Programs that Work and Why They Work. Marshall Room MINORITIES

9:15-10:15: **Deanna Banks Beanne,** Consultant in Education, *"Say Yes to a Youngster's Future,"* a National Urban Coalition Program. **Constance Tate,** Science Education Consultant, **Treopia Washington,** Program Associate, American Association for the Advancement of Science, and **Mary Johnson,** Washington, DC, Public Schools, *"Model Project to Increase Mathematics Achievement at the Secondary School Level."*

19.4. Human Genome Research: Ethical and Social Implications. Holmes Room BIOMEDICINE ETHICS

9:15-10:15: **Eric T. Juengst** (Organizer and Moderator), National Center for Human Genome Research, National Institutes of Health, Bethesda, MD. **Abby Lippman,** Department of Epidemiology, McGill University, Montreal, Canada, *"The 'Geneticization' of Health and Illness: Implications for Social Practice."* **Helen Bequart Holmes,** Hartford College for Women, Hartford, CT, *"Sequencing the Human Genome: A Feminist Assessment."* **Jude Payne,** Health Insurance Association of America, Washington, DC, *"Genetic Testing and Health Insurance: Prospects and Problems."*

19.5. Increasing Participation of Minorities in Science and Technology Fields: An NSTA Perspective. Kansas Room EDUCATION MINORITIES

The National Science Teachers Association is using many avenues to increase participation of minorities in science and technology education and careers. Present and planned initiatives will be presented.

9:15-10:15: **Bonnie Brunkhorst,** President, and **Napoleon Bryant,** Director, Division of Multicultural Education, National Science Teachers Association, Washington, DC.

19.6. Bridging the Two Cultures through STS Education. Calvert Room EDUCATION

9:15-10:15: **Connie Barlow** (Moderator), New York, NY, *"Biology as a Bridge to Worldviews."* **Clifford Matthews,** Department of Chemistry, University of Illinois at Chicago, *"Chemistry as a Bridge to Philosophy."* **George Bugliarello,** Polytechnic University, Brooklyn, NY, *"Technology as a Bridge to History."*

19.7. Engineering Ethics. Woodley Room ETHICS INTERNATIONAL

9:15-9:35: **Robert Thorburn McCutcheon,** University of the Witwatersrand, South Africa, *"Socio-Political Dimensions in Civil Engineering Education at the University of Witwatersrand."*

9:35-9:55: **Alastair S. Gunn,** University of Waikato, Hamilton, New Zealand, *"Engineering Ethics and Hazardous Waste Management: Why Should We Care About Future Generations?"*

9:55-10:15: **R. C. Hudspeth,** McMaster University, Hamilton, Ontario, *"Broadening the Scope of Engineering Ethics: From Micro Ethics to Macro Ethics."*

Moderator: **William F. Williams,** University of Leeds, UK.

19.8. Materials Science in the K-12 Curriculum. Vermont Room APPLIED SCIENCES

Promotion and hands-on discussion of curriculum and materials prepared by various groups.

9:15-10:15: **Gary Miller** (Moderator), Director of Materials Liaison Program, Lehigh University, Bethlehem, PA; **Irene D. Hays**, Manager, Science Education Center, Battelle Pacific NW Laboratories, Richland, WA **Ronald Latanalson,** Massachusetts Institute of Technology, Cambridge, MA; and **Jim Jacobs**, Norfolk State University.

Session 20: Papers and Workshops
Sunday 10:30-11:30 a.m.

20.1. Simplified Interactive Video for Teaching STS. Holmes Room EDUCATION

A technique for classroom teachers to combine their own videotaped experiments/interviews/special events with their own live teaching. Either as part of a team, or alone, teachers can produce STS materials, lessons, and courses to reflect their own geographic region.

10:00-11:30: **Minaruth Galey,** University of Colorado-Denver, CO, and **E. J. Piel**, SUNY-Stony Brook, NY.

20.2. Technological Progress: How Outsiders See It. Marshall Room MINORITIES WOMEN

Women, racial and ethnic minorities, and people with disabilities are gaining political, economic, and social recognition and power. How will future technologies reflect this inclusion?

10:30-11:30: **Lisa Novemsky** (Moderator), **Phyllis Bolling, Rose Dios, Doris Fleischer, Ronald Gautreau,** and **Frieda Zames**, New Jersey Institute of Technology, Newark, NJ, and **Phyllis Young Langford,** Trenton Board of Education, Trenton, NJ.

20.3. School-College Collaborations: Their Time Has Come. Calvert Room EDUCATION

Emphasis is on the various ways in which school-college collaborations and regional associations can assist STS programs and the exciting results of undergraduate participation and contributions.

10:30-11:30: **Francis J. Traino** (Moderator), **Gunnar Klevens, Tim Conway, David Gesner,** and **Peter Campbell,** Worcester Polytechnic Institute, Worcester, MA; and **Nancy Carriulo,** The Sanborn House, Winchester, MA.

20.4. Linking Environmental Education to Action. Woodley Room ENVIRONMENT EDUCATION

An environmental improvement project can be a desirable activity in environmental studies courses. This workshop will evaluate sample projects and develop criteria for success.

10:30-11:30: **Warren Leon,** Union of Concerned Scientists, Boston, MA.

20.5. Adapting Traditional Science Curricula to Female and Minority Students. Vermont Room MINORITIES WOMEN

This workshop will provide actual strategies that can help promote success in science and promote interest in science careers during the elementary years. Come join us in the investigation of this timely topic.

10:30-11:30: Meghan Twiest and **Edwina B. Bold**, Indiana University of Pennsylvania, Indiana, PA.

20.6. Environmental Issues with an STS Approach. Taft Room ENVIRONMENT EDUCATION

10:30-10:50: **Lloyd H. Barrow,** University of Missouri, Columbia, MO, *"Lawn Clippings: An STS Issue."*

10:50-11:10: **Frederick L Scott, Jr.**, International Scientific Communications, Inc., Baltimore, MD, *"The Fluoridation Controversy: A Challenge for the Application of STS Concepts."*

11:10-11:30: **John Pozzi,** Hallandale, FL, *"The Global Resource Bank."*

20.7. Using Community-Based Issues As a Context for STS Problem Solving and Decision Making. Roosevelt Room

Strategies for understanding science and technology interactions and the information processing, problem solving, and decision making skills needed to investigate community based STS issues. Instructional and curricular materials and research reports will be disseminated.

10:30-11:30: **John Ramsey,** University of Houston-University Park, TX.

20.8. It's Your World: New Curricula for Early Childhood and Primary Educators. Eisenhower Room EDUCATION

This is a hands-on mini-unit developed to stimulate thinking and problem-solving activities about the child's own environment that go beyond the classroom into the outside community. The challenging projects can be successfully acted upon by pre-kindergarden through grade 1 children, and can be adapted for older children as well.

10:30-11:30: **Bernice Hauser,** The Walden Lincoln School, New York, NY.

20.9. Technology and Society in the "Two-Thirds" World: Sociological, Scientific, and Cultural Dimensions. Johnson Room

An interdisciplinary discussion on sociology in Asia and Hispanic America, applied technology in Africa, Asia, and Hispanic America, and African and American literature on STS.

10:30-11:30: **Wayne G. Bragg** (Moderator) and **Eugene B. Schultz, Jr.**, Washington University, St. Louis, MO, and **Carl Wood,** Principia College, Elsah, IL.

20.10. Hands on Science at the Ecological and Physical Sciences Study Center, Oak Ridge National Laboratory. Thomas Paine Room ENVIRONMENT EDUCATION

10:30-11:30: **Terry L. Lashley, Director, Ecological and Physical** Sciences Study Center, Oak Ridge National Laboratory, Oak Ridge, TN.

BEST COPY AVAILABLE

Session 20: Sunday 10:30-11:30 a.m. (continued from previous page)

20.11. Computer Integrated Manufacturing and Its Impact on the Nature of Work. Ethan Allen Room. INDUSTRY

Today's industrial base is transforming from a mass production foundation to an automated environment. The use of the computer has become a major instrument in this change. The impacts upon work, its nature and skills have affected society at large. This technical tutorial will examine CIM and how it operates and affects work.

10:30-11:30: **James R. Gray,** Northern Kentucky University, Highlands Heights, KY.

20.12. Math and High Technology Training Programs. Truman Room EDUCATION

10:30-10:50: **Russell E. David,** Alfred E. Smith High School, Bronx, NY, *"Related Tech Math for the Nineteen Nineties."*

10:50-11:10: **Joseph E. Ryan**, Hingham Public Schools, MA, *"Computer Assisted Drafting for Gifted/Learning Disabled Elementary Students."*

11:10-11:30: **Christopher Chamuris**, Lawrence Middle School, Lawrenceville, NJ, and **Tom Thiele,** Siemens Corporate Research, Princeton, NJ, *"Interfacing Teachers & Technology: NJ's Technology Education Internship Program."*

20.13. The Persistence of Incandescence. Kennedy Room EDUCATION

The incandescent light has demonstrated a lifetime which belies its fragility and inherent inefficiency. It is a suitable centerpiece for STS teaching efforts.

10:30-11:30: **James J. Murphy,** Iona College, New Rochelle, NY.

20.14. Recovering and Reclaiming Ancient Technology. Kansas Room

Efforts at recovery of ancient technology have demonstrated that in many instances they were and continue to be the original "high technology" in the sense of both technical complexity and appropriateness to the cultural and environmental context.

10:30-11:30: **Romualdas Sviedrys** (Moderator), Polytechnic University, Brooklyn, NY; **Bernhard den Ouden**, University of Hartford, West Hartford, CT; and **Stewart M. Oakley**, California State University, Chico, CA.

20.15. Invited Paper: Eastern European Approaches to Education About Work and Technology. Dover Room. INDUSTRY INTERNATIONAL

10:30-11:30: **Henryk Szydlowski**, Adama Mickiewicz University, Poznan, Poland. *Introduced by:* **Deitrich Blandow,** Paedagosche Hochschule-Dr. Theodor Neubauer, Erfurt, Germany.

Session 21: Closing Plenary Sunday, 11:45 a.m. - 1:00 p.m.

21. Closing Plenary: Innovation and Improvement in Science for Non-Science Majors. Cotillion Ballroom.

Speaker: **Bassam Z. Shakhashiri,** Professor of Chemistry, University of Wisconsin-Madison, former Assistant Director for Science and Engineering Education, National Science Foundation, Author, *Chemical Demonstrations: A Handbook for Teachers of Chemistry* and *Manual for Laboratory Investigations in Chemistry*.

Introduced by: **Rustum Roy,** Professor of Materials Science, The Pennsylvania State University, University Park, PA, and NASTS Corporate Chair.

Closing remarks: **Stephen Cutcliffe,** Director of the Science, Technology and Society Program, Lehigh University, Bethlehem, PA, and TLC-6 Conference Chair.

NASTS Planning Meeting: Seventh Technological Literacy Conference Sunday, 1:30-4:00 p.m.

NASTS Planning Meeting for TLC-7. Warren Room. OPEN TO ALL CONFERENCE PARTICIPANTS.

THU., JAN 31	FRIDAY, FEB. 1	SATURDAY, FEB. 2	SUNDAY FEB. 3	
	SESSION 1 OPENING PLENARY (see page 8)	SESSION 9 (see pages 14-16)	SESSION 18 (see pages 23-24) NSTS COMMITTEE MEETINGS (see pg. 23)	8:00 a.m.
		SESSION 10 LYNN MARGULIS (see page 16)	SESSION 19 (see pages 24-25)	9:00
	SESSION 2 (see pages 8-9)	SESSION 11 (see pages 16-17)	SESSION 20 (see page 25-26)	10:00
		SESSION 12 (see page 17)	SESSION 21 BASSAM SHAKASHIRI (see page 26)	11:00
	SESSION 3 JESSE JACKSON (see page 9)	SESSION 13 (see pages 17-19)		12:00 p.m.
	SESSION 4 (see pages 10-11) INFORMATION MARKET-PLACE (see page 8)		NASTS PLANNING MEETING FOR TLC-7 (see page 26)	1:00
	SESSION 5 (see pages 11-12)	SESSION 14 ELISE BOULDING (see page 19)		2:00
	SESSION 6 (see page 12)	SESSION 15 (see pages 19-21)		3:00
		SESSION 16 (see pages 21-22)		4:00
	SESSION 7 (see pages 13-14)	SESSION 17 ANDREW WEIL (see page 22)		5:00
				6:00
PRE-CONFERENCE SESSIONS (see page 7)	SESSION 8 KENNETH DICKINSON WILLIAM STEVENSON (see page 14)			7:00
	NASTS BUSINESS MEETING (see page 14)	NASTS RECEPTION (see page 22) COMMUNITY MEETINGS (see page 23)		8:00
				9:00

TLC-6 CONFERENCE EVALUATION FORM

Please complete and return to registration table (boxes labeled "TLC-6 Evaluations") or mail before February 15, 1991 to NASTS, 133 Willard Bldg., University Park, PA, 16802.

1. With which one sector do you most closely affiliate?

____ Science and Engineering
____ Print and Broadcast Media
____ Public Interest Sector
____ K-12 Education
____ Post-Secondary Education
____ Museums, Science Centers, Other Informal Education
____ Profesion Pertaining to Values, Ethics, or Religion
____ Science and Technology Policy Making
____ International STS
____ Other: ________________________

2. What attracted you to this conference?

3. What did you like best about the conference?

4. What one aspect would you most like to see improved next year?

5. What topics would you most like to have covered next year?

6. Who would you like to hear address the conference next year?

7. Is there some way you would like to participate next year? (Include your name & phone number, or contact us.)

8. What do you think about the format of this year's conference program?

9. What do you think about the Sheraton Washington Hotel as a conference site?

10. What additional comments or suggestions do you have?